# A LIMITED ENERGY STUDY OF HIGH TEMPERATURE AND CHILLED WATER DISTRIBUTION SYSTEMS AT FORT STEWART AND HUNTER ARMY AIRFIELD, GEORGIA

## VOLUME II
## APPENDICES

## FINAL SUBMITTAL

Prepared For
Savannah District, Corps of Engineers

Contract Number DACA01-94-D-0038
Delivery Order Number 0002

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September 6, 1996

6941331002



| Forces Command | 3rd Infantry Division<br>Fort Stewart | Savannah District<br>Corps of Engineers | Reynolds, Smith and Hills, Inc. |
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DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
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# A.1 SCOPE OF WORK

APPENDIX A
for Delivery Order No. 2,

A LIMITED ENERGY STUDY OF HIGH TEMPERATURE AND CHILLED WATER DISTRIBUTION SYSTEMS AT FORT STEWART AND HUNTER ARMY AIRFIELD, GA

1. BRIEF DESCRIPTION OF WORK:
The Architect-Engineer (A-E) shall perform the following:

1.1 Field Investigation.

1.1.1 High Temperature Water (HTW) Distribution Systems. Develop a plan for and conduct a field survey to identify points or areas in the HTW distribution system at Fort Stewart where energy leaks occur, describe and estimate the cost of the Energy Conservation Opportunities (ECO's) to close these leaks in the most technically sound and cost-effective manner for the long-term, and perform a Life Cycle Cost Analysis (LCCA) to determine whether any or all of the recommended ECO's qualify for funding under the criteria for the Federal Energy Management Program (FEMP) or the Energy Conservation Investment Program (ECIP). At Hunter Army Airfield (HAAF) the A-E will review all available data and records for both the Central Energy Plant (CEP) and the pinwheel barracks energy plant and interview all personnel that the Fort Stewart Energy Officer (FSEO) can direct him to. Based on an analysis of the gathered information, the A-E will recommend whether or not further study of the HAAF HTW distribution systems should be programmed for the future.

1.1.2 Chilled Water (CHW) Distribution Systems. Review all data and records related to the Fort Stewart CHW distribution system and interview all personnel that the FSEO can direct him to. Based on this review, the A-E will make a recommendation as to whether or not a field investigation of the CHW system is needed. For HAAF the A-E will review all available records and data for both the CEP and and the pinwheel barracks energy plant and interview all personnel that the FSEO can direct him to. Based on an analysis of the gathered information, the A-E will recommend whether or not further study of the HAAF CHW distribution systems should be programmed for the future.

1.2 Project Identification and Documentation. The A-E is instructed to fully analyze and document one particular alternative for the Fort Stewart HTW distribution system: complete replacement of the existing distribution lines with a shallow trench distribution system. Other alternatives or projects will be identified by the A-E or government reviewers as a result of the study, and the A-E will provide complete programming or implementation documentation for all recommended projects, which may be individual ECO's or more than one ECO combined. Guidance from the participants in this project from Fort Stewart and Forces

Command (FORSCOM) will be given to the A-E at the interim submittal review stage as to how best to package ECO's for funding purposes.

1.3 Study Report. Provide a comprehensive report to document all work performed, the results and conclusions, and all recommendations.

2. SPECIFIC INSTRUCTIONS:

2.1 Field Investigation.

2.1.1 Plan for the field investigation. Prior to beginning any detailed system investigations at Fort Stewart, the A-E will be required to develop and submit for the other project team members' information a plan of action for the actual field work. As a minimum, it will include a weekly schedule of anticipated events, the techniques that will be used for surveying underground distribution lines, and a map annotated to depict the plan of attack for surveying the full length of all distribution lines and other distribution system components from the points of departure out of the Central Energy Plant (CEP) to the points of connection to each facility that is an end user of the energy supplied by the plant. In order to accomplish this, the A-E will be required to visit the intallation and:

2.1.1.1 Obtain a complete set of distribution system maps for Fort Stewart and HAAF. These will be annotated in the field during the detailed survey of the distribution systems. All inaccuracies or changes that are noted will be posted to the field maps. These annotated maps will be part of the interim submittal.

2.1.1.2 Review records of work orders and service orders, obtainable from the Resource Management Divisions and/or the Facilities Engineering Divisions at the respective installations, for the most recent twelve month period. This will assist the A-E in defining the areas most suspected of having energy leaks, where he may need to concentrate more of his field effort.

2.1.1.3 Interview personnel assigned to both Fort Stewart and HAAF most knowledgeable about the distribution systems, starting with the responsible division chiefs and proceeding through the organizational chain of command to the line workers responsible for operation, maintenance, and repair of the systems.

2.1.1.4 Review logs of make-up water volumes at the CEP. This study is directed to the correction of energy losses in the distribution system. Some investigation of equipment in the central plant and in the buildings served by the system may be necessary to aportion makeup water uasge among the distribution system, the CEP, and the building mechanical rooms. Sufficient field time should be devoted to these areas to gather the needed information.

2.1.2 <u>Field survey.</u>

2.1.2.1 The A-E will send sufficient personnel to the installations to complete the detailed field survey in the least amount of time possible. Contractor-developed forms designed to speed the process of conducting the field survey and contractor-controlled equipment and vehicles shall be available in adequate numbers to insure that the field crew(s) are never deadlined.

2.1.2.2 There will be a field survey manager appointed who will serve as the on site point of contact, who will be fully knowledgeable of the previous planning effort for the field survey, and who will serve in this capacity from beginning to end of the field survey. This individual will be required to report to the FSEO, or his project manager at the Savannah District, on a weekly basis. The field manager will have the authority to make those decisions necessary to finish the work in a thorough, high quality, and timely manner.

2.1.2.3 There are several non-destructive inspection techniques that can be employed to gather the information to pinpoint the sections in the systems where insulation has deteriorated to the degree that hot or cold spots are apparent, where water under pressure is leaking from lines or other parts of the system to include equipment in above ground components such as valve pits, or where energy losses in the system are occuring for other reasons. These include visual inspection, flow metering, infrared thermography, ground penetrating radar, SF6 leak detection, and video inspection. Other techniques with which the Contractor may have more familiarity or the technology for which has more recently been developed will be acceptable if they will produce the desired results and if they are identified in the plan for the field survey. The A-E will be responsible for the timing and coordination of the inspections and any peculiar requirements of a particular type and will be required to have his own equipment with which to perform the inspections by whatever technique(s) he chooses. The A-E will also be responsible for insuring that all safety standards are followed.

2.2 <u>Project Identification and Documentation.</u> All assumptions, formulas, input and output values, and the actual calculations used in generating project cost estimates and savings will be included with each ECO. All energy conservation opportunities or projects which the A-E has considered shall be included in one of the following categories and presented in the report as such:

2.2.1 <u>Federal Energy Management Program (FEMP) Projects:</u> Every attempt will be made to keep <u>all</u> projects within the Installation Commander's funding approval authorities applicable to the Operations and Maintenance, Army (OMA) account. These limitations are generally $300,000 for a project classified as construction and $1,000,000 for projects classified as maintenance

or repair, as defined in reference 9.2 and modified by reference 9.10. There is a special source of OMA funding called the FEMP that can generally provide funding for energy savings type projects, the cost of which are estimated to fall below these limitations, on a one year cycle or less, if a project is properly justified. To be classified as an OMA Energy maintenance or repair project, the project must result in needed maintenance or repair to an existing facility or replace a failed or failing system or component and result in energy savings. If the project would replace a system or component that is considered failed or failing due solely to obsolete technology or inefficiency, the system or component to be replaced must have been in use for at least three years and the simple payback period must be ten years or less. So long as the work can be logically separated and identified, projects can be combined in one undertaking. Any recommended project must have, as a minimum, a Savings to Investment Ratio (SIR) of 1.25 and a simple payback period of 10 years or less. The documentation required for each project is the life cycle cost analysis (LCCA) summary sheet completely filled out, a description of the work to be accomplished, backup data for the LCCA (i.e., energy and non-energy savings calculations and cost estimate), the SIR, and the simple payback period. The documentation of these projects will be a part of the study report described below.

2.2.2 Energy Conservation Investment Program (ECIP) Projects. If a project cost estimate is greater than the limitations mentioned above, then the project becomes an ECIP project by definition. An ECIP project is one that proposes new construction or a retrofit of an existing facility for the purpose of conserving energy. In an ECIP project, savings may come from energy, demand, operations and maintenance, other factors, or a combination of the above. In addition to the cost threshhold, a project must also have an SIR greater than 1.25 and a simple payback period of less than ten years to meet the minimum criteria for ECIP projects. Where ECO's have been combined into one ECIP project, each discrete part must meet the SIR and simple payback criteria. Programming documentation shall consist of a DD Form 1391 and an LCCA summary sheet with necessary backup data to verify the numbers presented. An LCCA summary sheet shall be developed for each ECO and for the overall project when more than one ECO have been combined.

2.2.3 Low Cost/No Cost Projects. These are projects which the DPW can complete using his in-house work force. Minimum documentation will consist of a description of the project, a sketch of the location and the work required, a rationale for why the project is recommended, and a cost estimate. Other project documentation requirements may be added by the FSEO.

2.2.4 Nonfeasible ECO's. All ECO's which the A-E has considered but which are not feasible shall be documented in the report with reasons and justifications showing why they were rejected.

2.3 Study Report. The work accomplished shall be fully documented by a comprehensive report. While the cost of report production is certainly a consideration, the report submittals must be well organized and lend themselves to quick and easy review because the installation staff will have only limited time available for this. The A-E is expected to compile the information for the submittals in a logical sequence and must take great care to consider the reader's point of view. Spelling, grammar, and punctuation will be checked prior to making a submittal; and, for clarity, highly technical terms will be explained. Before making copies for each submittal, the report will be proofread and critiqued by an employee of the firm not familiar with the project to insure good readability. Just as important as any other part of the effort, the A-E must be concise in conveying the key information to the customer. Following these rules will help to insure that the A-E's credibility will not suffer and that his technical capabilities will not be questioned.

The interim submittal may be copied and bound in the most convenient and least expensive manner, so long as it meets the criteria above. The pre-final report will be organized, tabbed, copied, and bound in the exact manner which the A-E proposes to produce the final report. Review of both submittals will include comments on the report's organization and flow of thought. The final report will incorporate all earlier comments and, if the pre-final report is produced properly, will be produced by page for page replacement in or page addition to the pre-final report. A high quality 3-ring binder will be used to package the pre-final report.

For easy reading line length on the printed page is a consideration. It may be adviseable to use a two column format to accomplish this. The pages of the original copy will be laser printed. Xeroxed copies on high quality paper are acceptable so long as there is essentially no discernible difference between them and the original. A title page will be inserted in a sleeve on the front cover and will contain a photograph descriptive of the report contents. The inside title page will also incorporate logos and credits to the A-E and the offices which have played a role in development of the study and report, particularly the installation. This will be followed by a table of contents. Each section, subsection, and appendix shall be separated by a thick paper divider tabbed with the section name and number. Each page will be numbered with a section number followed by a dash and a page number.

A separately bound Executive Summary of the study, giving a brief overview of the conclusions and recommendations using graphs, tables, and charts as much as possible, will be prepared as part of the final submittal. For clarity, color will be used in these graphic elements or any others that appear in the report. The body of the report itself--i.e., that portion where the technical analysis, conclusions, and recommendations are developed--shall be organized in a logical manner and written simply enough for a person not an expert in the field to follow the line of reasoning for each project. All project documentation will be presented in this portion of the report. Appendices will include as a minimum

the Scope of Work for this D.O., minutes of meetings, and survey forms. Any other appendices that the A-E thinks will assist in making the report better and more organized are also encouraged. If acronyms are used, there will be a list of each one used with a definition.

3. SERVICES AND MATERIALS: All services, materials (except those specifically enumerated to be furnished by the Government), plant, labor (including that required to research installation records or databases to obtain all information needed to perform a thorough study), equipment, supervision, and travel necessary to complete the work and render the data required under this D.O. are to be included in the lump sum price.

4. GENERAL:

4.1 The information and analysis outlined herein are considered to be minimum requirements for adequate performance of this study. The A-E is encouraged to use his specialized knowledge in this field to provide additional information which will help the installation justify energy improvement projects.

4.2 For the distribution systems described above all methods of energy conservation which are reasonable and practical shall be considered, including improvements of operational methods and procedures as well as the physical facilities. All systems improvements that are considered during the study will be documented in the report, including those that are rejected because they are considered infeasible with reasons given for elimination. If, under another set of assumptions, an infeasible project will become feasible, then so state. For example, if using in-house labor to perform work would be less costly than using contract labor, and this change would result in meeting the SIR and payback criteria, then document this.

4.3 The "Energy Conservation Investment Program (ECIP) Guidance," described in a letter from DAIM-FDF-U, dated 10 Jan 1994, and any subsequent revisions establish criteria for ECIP projects and shall be used for performing the economic analyses associated with these projects. The software program, Life Cycle Cost in Design (LCCID), has been developed for performing life cycle cost calculations in accordance with ECIP guidelines and is referenced in the ECIP guidance. If any program other than LCCID is proposed for life cycle cost analysis, it must use the mode of calculation specified in the ECIP guidance. The output must be in the format of the ECIP LCCA summary sheet, and it must be submitted for approval to the Contracting Officer. The LCCID program is available from the BLAST Support Office at 144 Mechanical Engineering Building, 1206 West Green Street, Urbana, Illinois 61901 for a nominal fee. The telephone number is (217) 333-3977 or (800) 842-5278.

4.4 The A-E shall take great care to insure that the FSEO is kept apprised of the ongoing work, either directly or through periodic contact with his Savannah District project manager. The final recommended projects will be both technically and economically feasible and will be acceptable to the FSEO.

4.5 Public Disclosures. The A-E shall make no public announcements or disclosures relative to information contained or developed in this contract, except as authorized by the Contracting Officer.

4.6 Meetings. Meetings will be scheduled whenever requested by the A-E or the government's representative acting for the installation project manager for the resolution of questions or problems encountered in the performance of the work. These meetings, if necessary, will be in addition to the scheduled review meetings and presentations.

4.7 Site Visits, Inspections, and Investigations. The Contractor shall visit and inspect/investigate the site of the projects as necessary and required during the preparation and accomplishment of the work. Visits will be coordinated with the FSEO at least a week in advance. The A-E will determine whether any special security clearances are required with the assistance of the FSEO.

4.8 All invoices or payment estimates (ENG Form 93) will be sent to the Savannah District project manager, who is identifed below in paragraph 5.4, for review and approval.

4.9 Records.

4.9.1 The A-E shall provide a record of all significnt conferences, meetings, discussions, verbal directions, telephone conversations, etc., with government personnel relative to this project in which the A-E has participated. These records shall be dated and shall identify the contract and D.O. number, participating personnel, subject discussed, and conclusions reached. The A-E shall forward by letter to the list of P.O.C.'s in paragraph 5 within ten calendar days of the event a reproducible copy of the records. These will also be included in the study report as an appendix.

4.9.2 The A-E should expect to provide the manpower needed for, and should base his fee proposal on, gathering all information himself required to complete the study. But, if the A-E faces a situation where he must request the installation's assistance, then he shall provide a record of requests for and/or receipt of Government-furnished material, data, documents, information, etc., which if not furnished in a timely manner, would significantly impair the normal progression of the work under this D.O. The records shall be dated and shall identify the contract and D.O. number. The A-E shall forward to the Savannah District project manager within ten calendar days a reproducible copy of the record

of request or receipt of material.

4.10 Briefings. The A-E and the Savannah District project manager shall conduct entry and exit interviews with the DPW, or his designated representative as instructed by the FSEO, before starting work at the installation and after completion of the study.

4.10.1 Entry. The entry interview shall describe the purpose of the study, the intended procedures for the survey, the schedule, names of personnel performing the field investigation and the A-E's project manager, support required by the A-E of the DPW staff, a description of the final products, and any other information the A-E wishes to communicate and shall be conducted prior to commencing work at the installation.

4.10.2 Exit. The exit interview shall describe the items surveyed, an assessment of the condition of existing systems, and the results and conclusions of the analysis.

5. PROJECT MANAGEMENT:

5.1 The A-E shall designate a project manager, in addition to the field survey manager mentioned above, who will serve as the primary P.O.C. and liaison for work required under this D.O. If the A-E chooses, the same person can serve in both capacities but must be on site throughout the field survey. Upon award of this D.O., the individual shall be immediately designated in writing. The A-E's designated project manager shall be approved by the Contracting Officer prior to commencement of work. The project manager will be responsible for coordination of work required under this D.O. The A-E's project manager shall submit monthly progress reports, typically in conjunction with pay requests, and shall telephonically update the Savannah District project manager on project events about every two weeks between pay requests. Immediately upon award of this D.O., the A-E's project manager will submit a project schedule substituting dates for calendar days, with an assumed 28 calendar day government review period after each submittal.

5.2 The Fort Stewart Energy Officer and installation project manager for this effort is Doug Swanson, telephone number (912) 767-7925, FAX number (912) 767-9779. He will assist the A-E in obtaining information and establishing contacts necessary to accomplish the work required under this D.O.

5.3 The U.S. Forces Command program manager is Naresh Kapur, telephone number (404) 669-5327, FAX number (404) 669-7751.

5.4 The U.S. Army Corps of Engineers, Savannah District, project manager is Rob Callahan, telephone number (912) 652-5246, FAX number (912) 652-5442.

5.5 The U.S. Army Corps of Engineers, Savannah District, Contracting Officers Representative is Tom Clarke, telephone number (912) 652-5364, FAX number (912) 652-5090.

5.6 The U.S. Army Corps of Engineers, Mobile District, is the Army's designated Technical Center of Expertise for the Energy Engineering Analysis Program. Mobile District's program manager is Tony Battaglia, telephone number (205) 690-2618, FAX number (205) 690-2424.

6. SUBMITTALS, PRESENTATIONS, AND REVIEWS:

6.1 Interim Report Submittal. An interim report, which will include all field notes, shall be submitted for review after the field survey has been completed and an analysis has been performed on all of the ECO's. The report shall indicate the work which has been accomplished to date, ilustrate the methods and justifications of the approaches taken and contain a plan for the work remaining to complete the study. One copy of the interim report shall be submitted for review to the FORSCOM and Mobile District P.O.C.'s. Two copies of the report shall be submitted to the Fort Stewart and Savannah District P.O.C.'s. Calculations showing energy and dollar savings, SIR, and simple payback period of all the ECO's shall be included. The results of the ECO analyses shall be summarized by lists as follows:

6.1.1 All ECO's eliminated from consideration shall be grouped into one listing with reasons for their elimination as discussed in paragraph 2.2.4.

6.1.2 All ECO's which were analyzed shall be grouped into two listings, recommended and non-recommended, each arranged in order of descending SIR. These lists may be subdivided by location or area as appropriate for the study.

6.1.3 The A-E shall make a presentation of the report at a review conference. Visual aids or other methods of presentation will be at the A-E's discretion to make understanding by those present easier.

6.2 Pre-final Report Submittal. The A-E shall prepare and submit the pre-final report when he believes all work under this D.O. is essentially complete. The report will be formatted and bound exactly as the A-E proposes to format the final report. All project documentation shall be completed and included in the report. All comments resulting from review of the interim submittal or from the presentation shall have been addressed in compiling this report, and review action comments related to the interim report shall be included in a separate appendix keyed to sections of the pre-final report where the appropriate changes have been made. The same number of copies shall be sent to the same offices as specified above for the interim report.

6.3 Final Report. Any revisions or corrections resulting from comments made during the review of the pre-final report will be able to be incorporated by page for page replacement in or page addition to the pre-final report, if it has been produced in accordance with these instructions. All instructions on organization and formatting shall be strictly followed. A separately bound Executive Summary will be prepared, as described above in paragraph 2.3. One copy each of the final submittal shall be sent to the FORSCOM and Mobile District P.O.C.'s; two copies each shall be sent to the Savannah District P.O.C.; and three copies, along with the original, shall be sent to the Fort Stewart P.O.C. In addition one copy each of only the Executive Summary shall be sent to the Corps of Engineers, South Atlantic Division, P.O.C., the U.S. Army Logistics Evaluation Agency P.O.C., and to the HQUSACE P.O.C. listed below in paragraph 8.

7. <u>PROJECT SCHEDULE</u>:

| Milestone | Date |
|---|---|
| Entry interview and begin gathering information | NLT 14 days after award of this D.O. |
| A-E submits recommendations on further studies and field survey plan | NLT 42 days after award of this D.O. |
| A-E begins field survey | As described in field survey plan |
| A-E completes field survey | As described in field survey plan |
| A-E submits interim report | NLT 154 days after completion of field survey |
| Interim submittal review meeting and presentation | NLT 7 days after completion of government review |
| A-E submits pre-final report | NLT 56 days after interim submittal review meeting |
| A-E submits final report | NLT 28 days after receipt of government review comments on pre-final |
| Exit briefing | NLT 14 days after submitting final report |

8. <u>POINTS OF CONTACT</u>:

Commander
24th Infantry Division and Fort Stewart
ATTN: AFZP-DEV ~~(Mr. Doug Swanson)~~ (Mr. Tim Harper)
Fort Stewart, GA 31314

Commander
U.S. Army Forces Command
ATTN: AFPI-ENO (Mr. Naresh Kapur)
Fort McPherson, GA 30330

Savannah District, Corps of Engineers
ATTN: CESAS-PM-MR (Mr. Rob Callahan)
100 W. Oglethorpe Avenue
P.O. Box 889
Savannah, GA 31402-0889

Mobile District, Corps of Engineers
ATTN: CESAM-EN-DM (Mr. Tony Battaglia)
P.O. Box 2288
Mobile, AL 36628-0001

Commander
U.S. Army Engineer Division, South Atlantic
ATTN: CESAD-EN-TE (Mr. Baggette)
77 Forsyth Street, SW
Atlanta, GA 30335-6801

Commander
U.S. Army Corps of Engineers
ATTN: CEMP-ET (Mr. Gentil)
20 Massachusetts Avenue, NW
Washington, DC 20314-1000

Commander
U.S. Army Logistics Evaluation Agency
ATTN: LOEA-PL (Mr. Keath)
New Cumberland Army Depot
New Cumberland, PA 17070-5007

9. <u>REFERENCES</u>:

9.1 Architect and Engineer Instructions, 9 Dec 91

9.2 AR 420-10, Management of Installation Directorates of Engineering and Housing, 2 Jul 87

9.3 AR 415-15 (DRAFT), Army Military Construction Program Development and Execution

9.4 Energy Conservation Investment Program (ECIP) Guidance, 10 Jan 94

9.5 TM 5-785, Engineering Weather Data

9.6 TM 5-800-4, Programming Cost Estimates for Military Construction, Feb 94

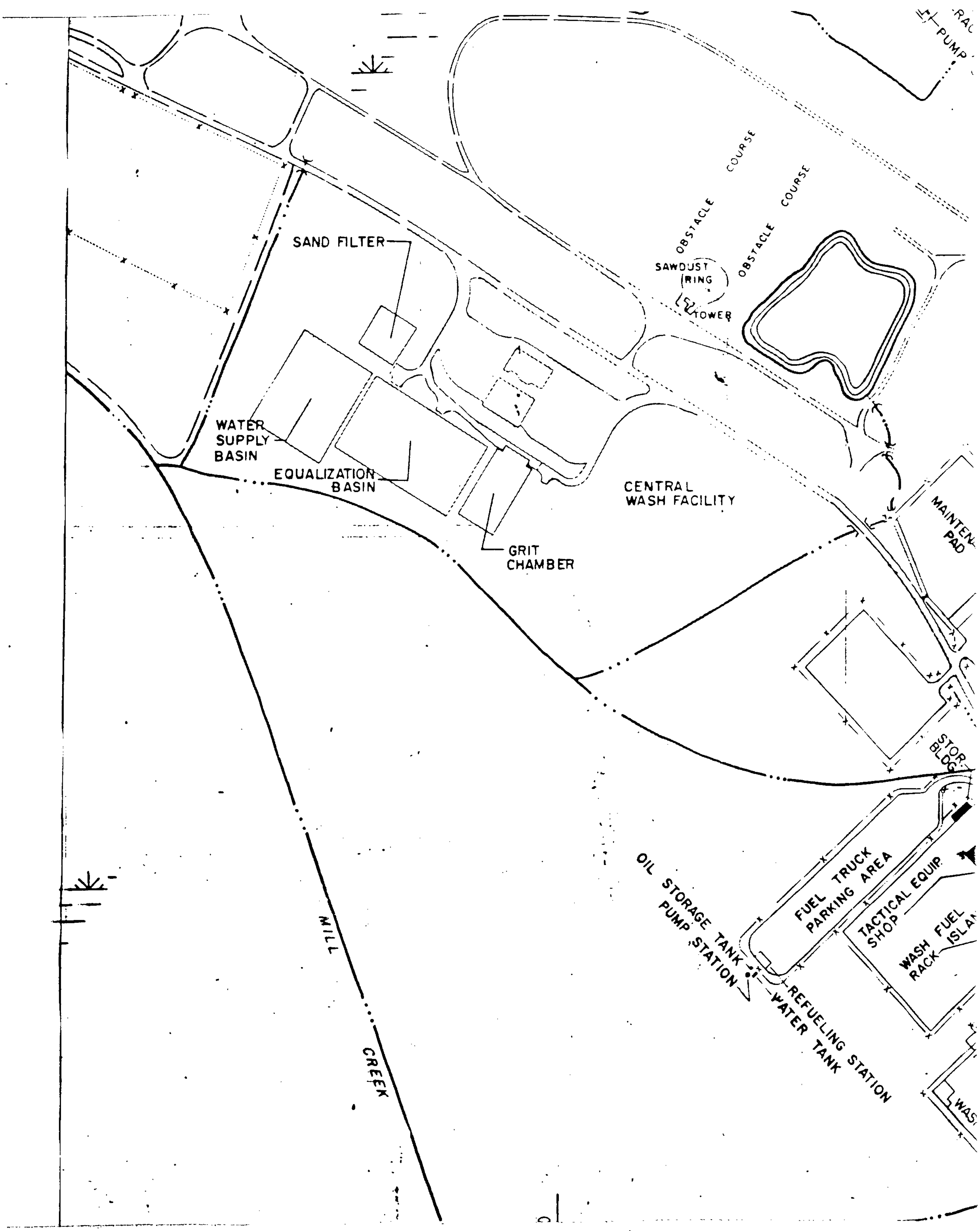
9.7 General Energy Conservation Opportunities

9.8 Required DD Form 1391 Data

9.9 AR 11-27, Army Energy Program, 14 Jul 89

9.10 TWX dated 111600Z Jul 94 from DAIM-FDF-B, subject: Future Change to AR 420-10

# A.2 HTW DISTRIBUTION SYSTEM MAP



PUMP
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OBSTACLE COURSE
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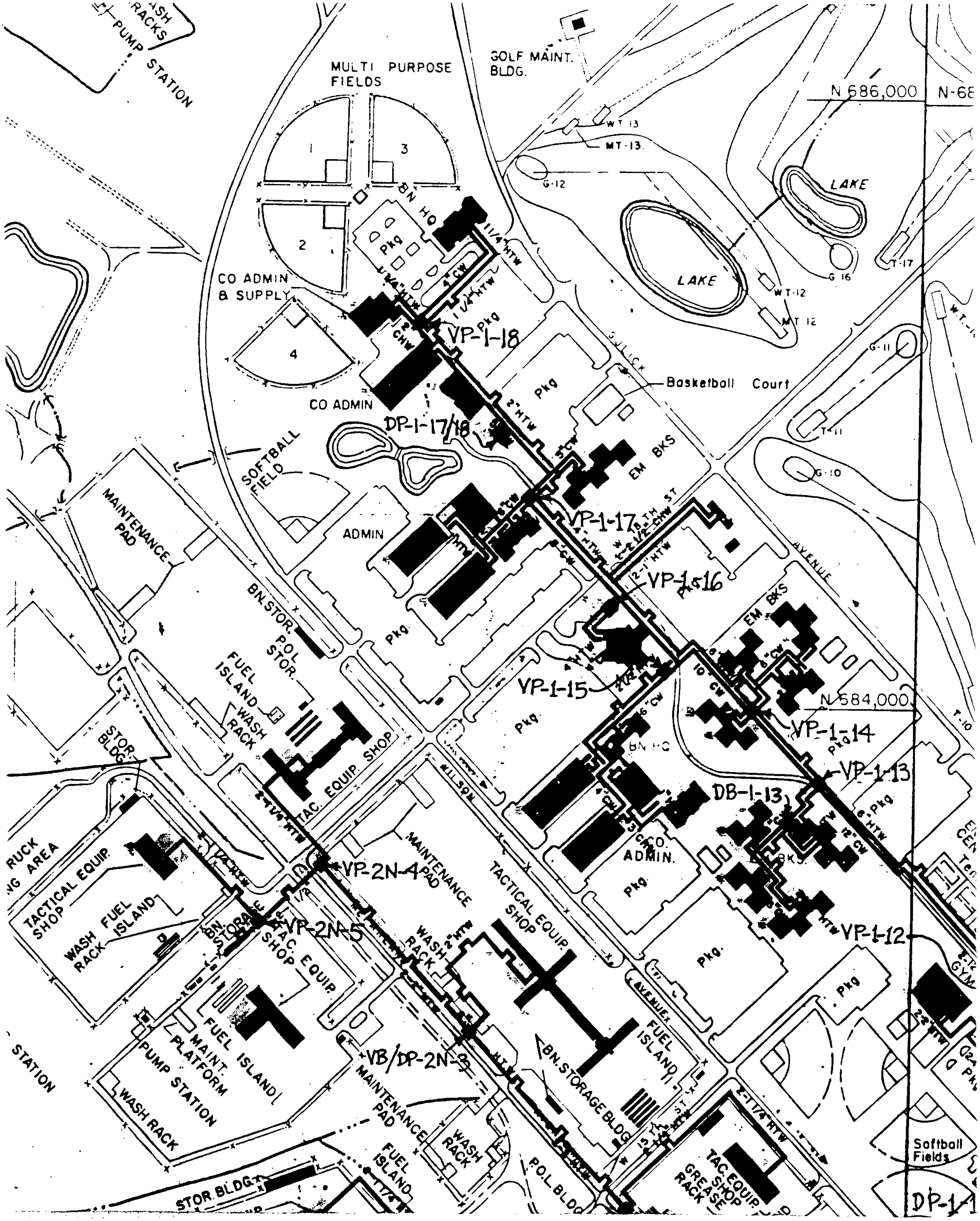
TOWER
SAND FILTER
WATER SUPPLY BASIN
EQUALIZATION BASIN
GRIT CHAMBER
CENTRAL WASH FACILITY
PAD
BLDG
FUEL TRUCK PARKING AREA
TACTICAL EQUIP. SHOP
WASH RACK
OIL STORAGE TANK PUMP STATION
REFUELING STATION
WATER TANK
MILL CREEK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LAKE
T-17
G 16
WT-12
MT 12
G-11
T-11
G-10
BN HQ
Pkg
11/4" HTW
4" CW
CO ADMIN & SUPPLY
VP-1-18
4
CO ADMIN
2" HTW
Basketball Court
DP-1-17/18
SOFTBALL FIELD
EM BKS
MAINTENANCE PAD
ADMIN
VP-1-17
AVENUE
VP-1-16
BN. STOR.
POL STOR.
FUEL ISLAND
WASH RACK
EM BKS
VP-1-15
N 584,000
VP-1-14
STOR BLDG.
TAC. EQUIP. SHOP
BN HQ
VP-1-13
DB-1-13
WILSON
MAINTENANCE PAD
CO. ADMIN.
BKS
RUCK NG AREA
TACTICAL EQUIP. SHOP
VP-2N-4
TACTICAL EQUIP SHOP
WASH FUEL RACK ISLAND
VP-2N-5
BN. STORAGE
TAC. EQUIP. SHOP
WASH RACK
VP-1-12
GYM
FUEL ISLAND
MAINT. PLATFORM
AVENUE
PUMP STATION
STATION
WASH RACK
VB/DP-2N-3
BN. STORAGE BLDG
MAINTENANCE PAD
WASH RACK
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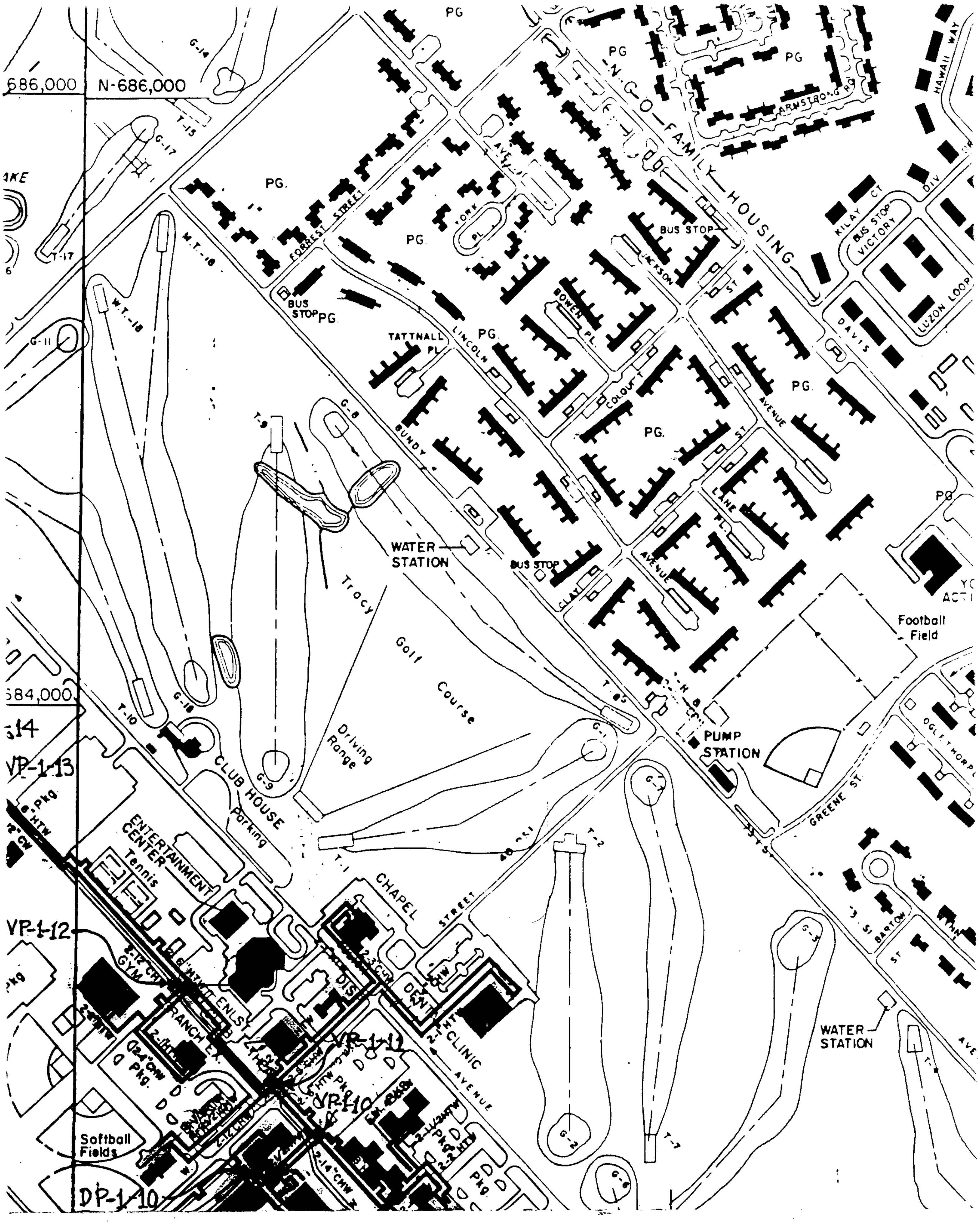
TAC. EQUIP. SHOP GREASE RACK
2-11/4" HTW
Softball Fields
STOR BLDG.
DP-1-1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FORREST STREET
YORK PL
BUS STOP
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KILAY CT
VICTORY
LUZON LOOP
DAVIS
BOWEN PL
TATTNALL PL
LINCOLN
COLQUITT
AVENUE
BUNDY
LANE PL
WATER STATION
Tracy Golf Course
Driving Range
CLAY
Football Field
PUMP STATION
OGLETHORPE
GREENE ST
CLUB HOUSE
Parking
ENTERTAINMENT CENTER
Tennis
CHAPEL STREET
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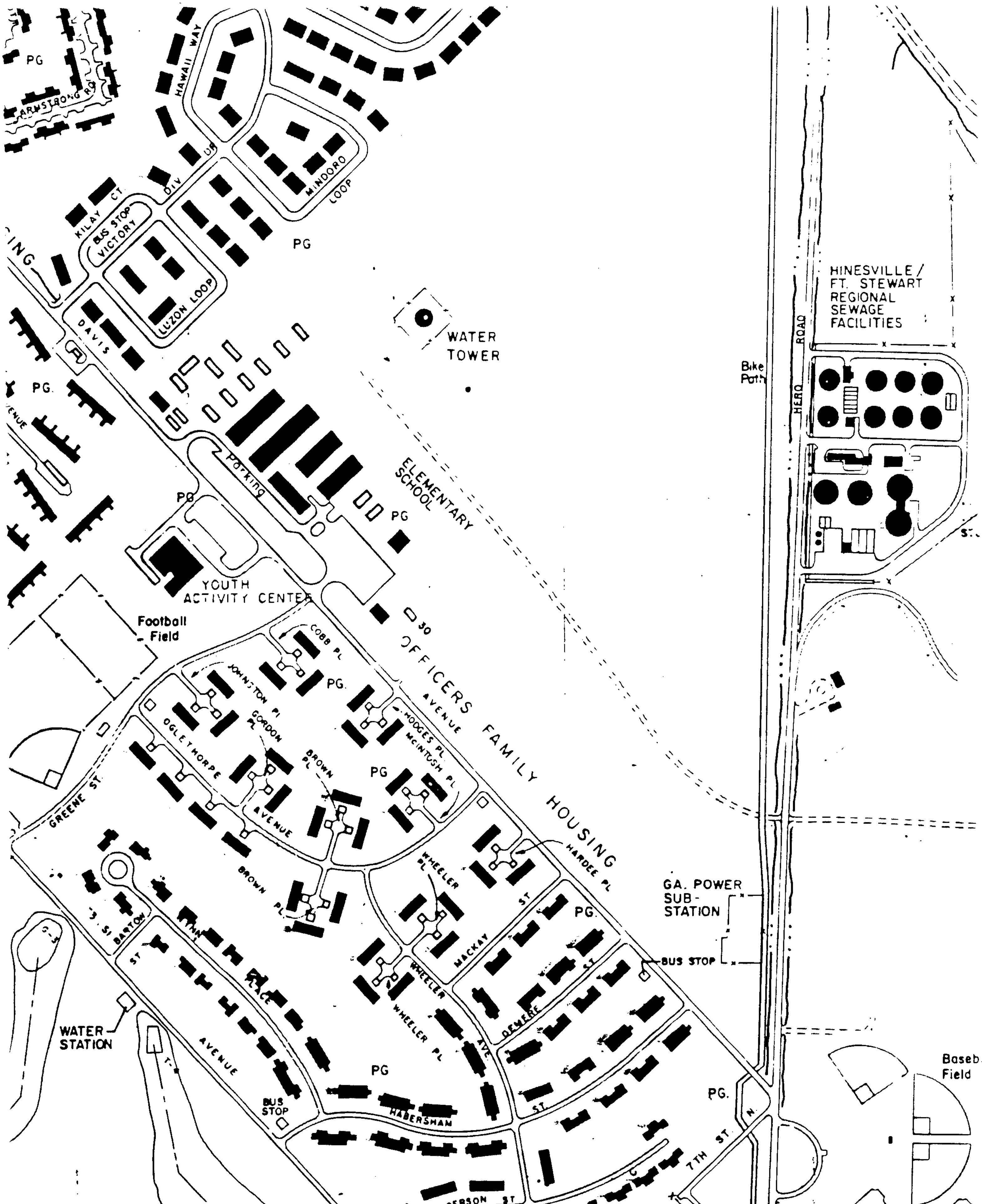

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ARMSTRONG PL
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MINDORO LOOP
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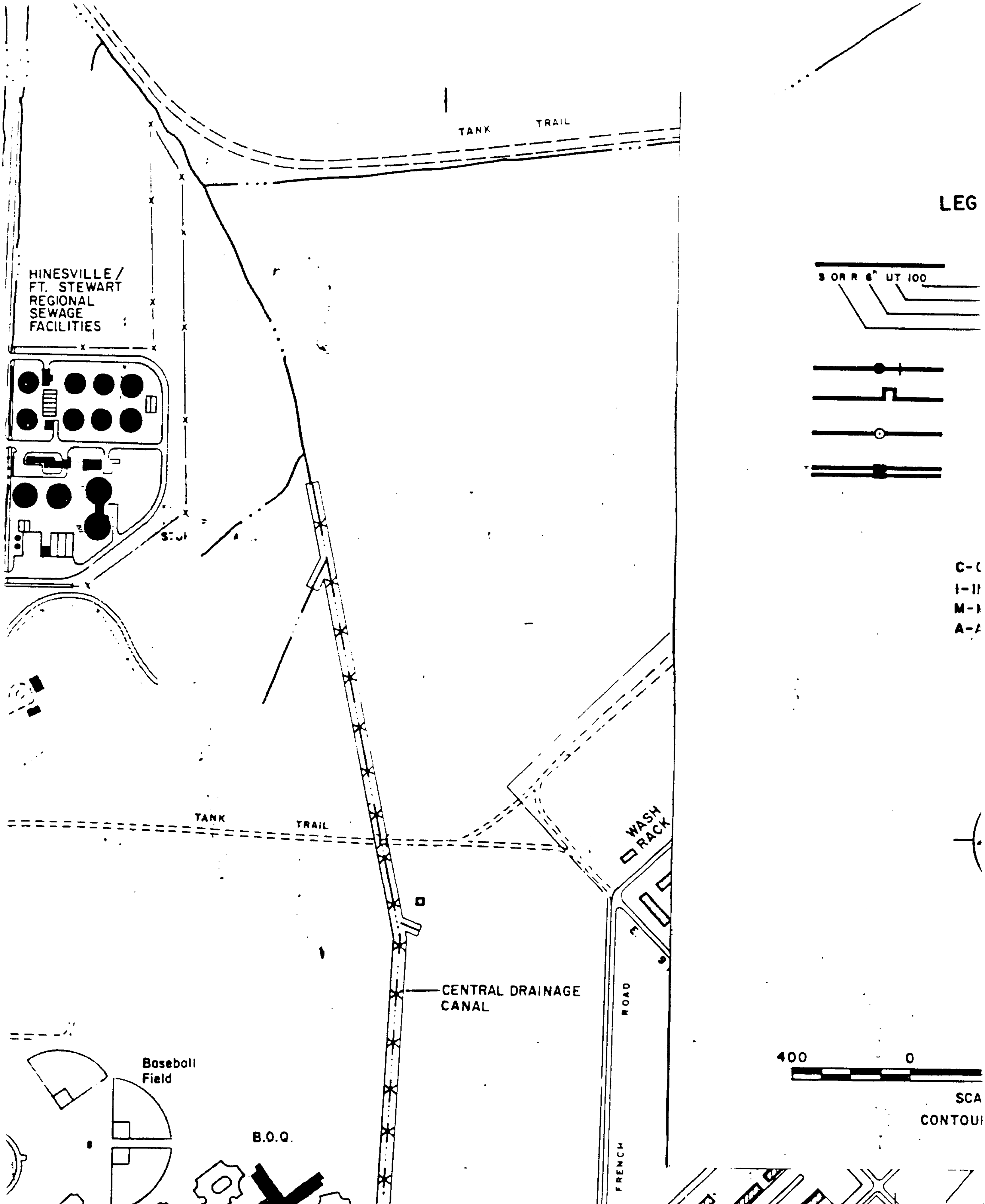
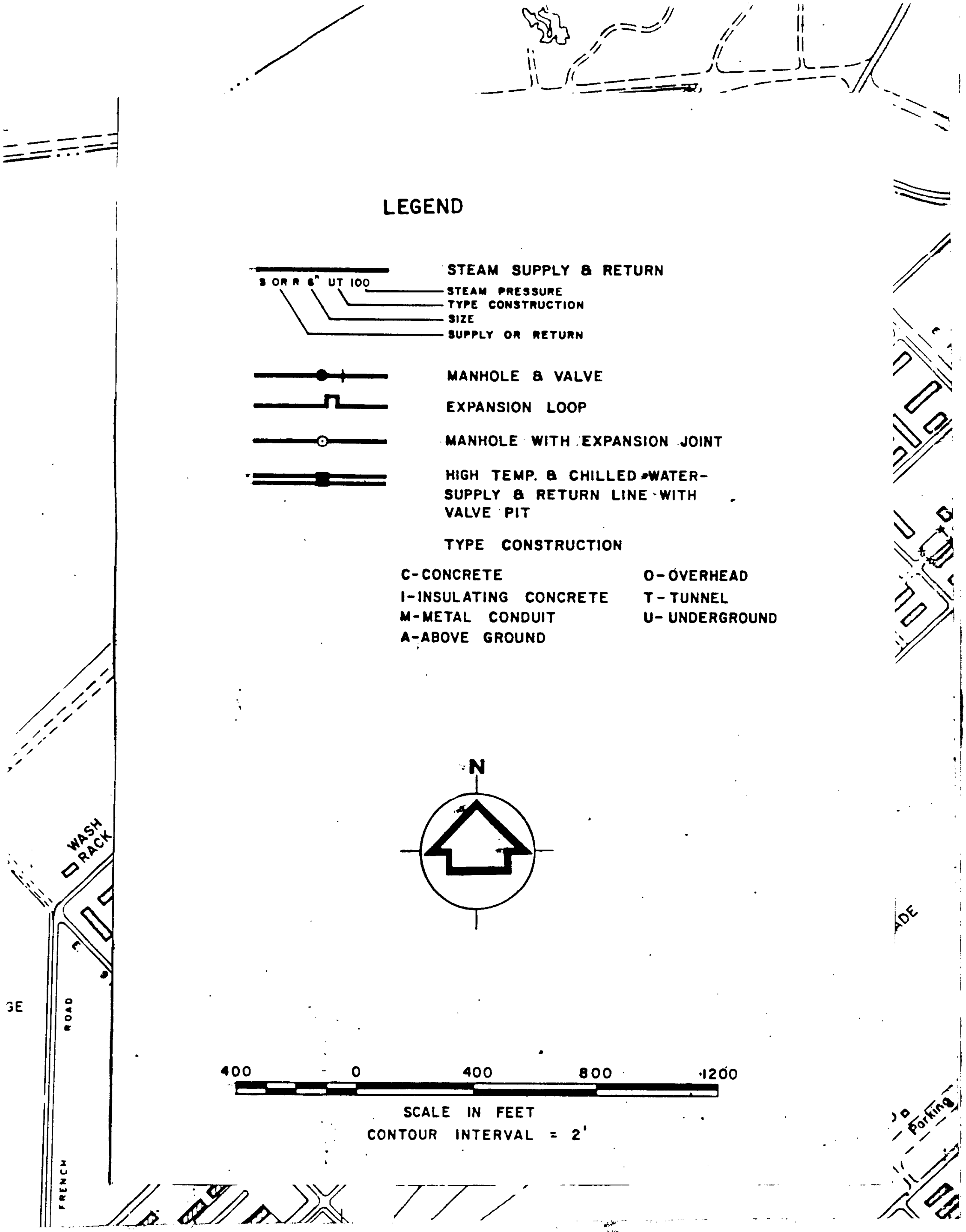
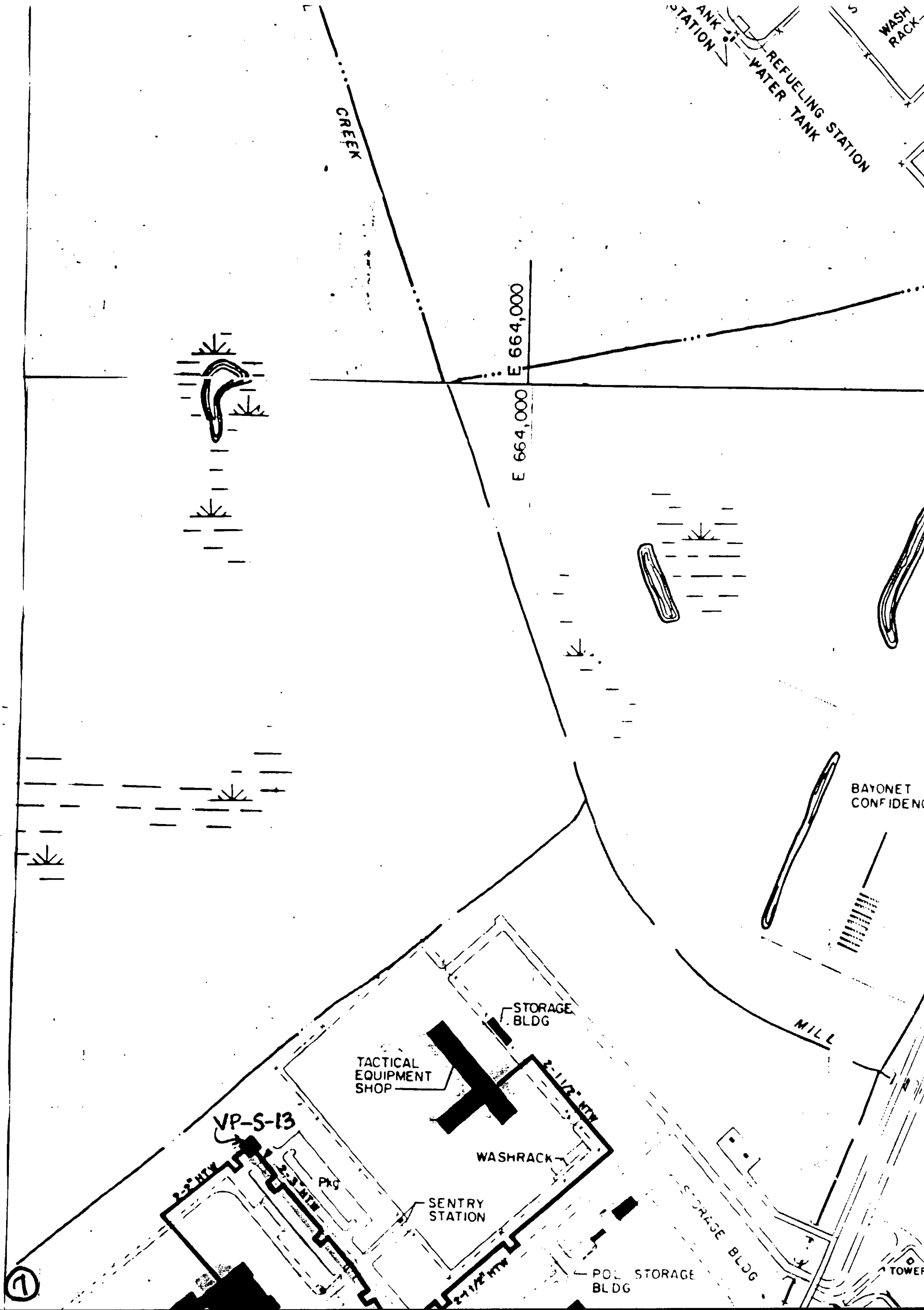
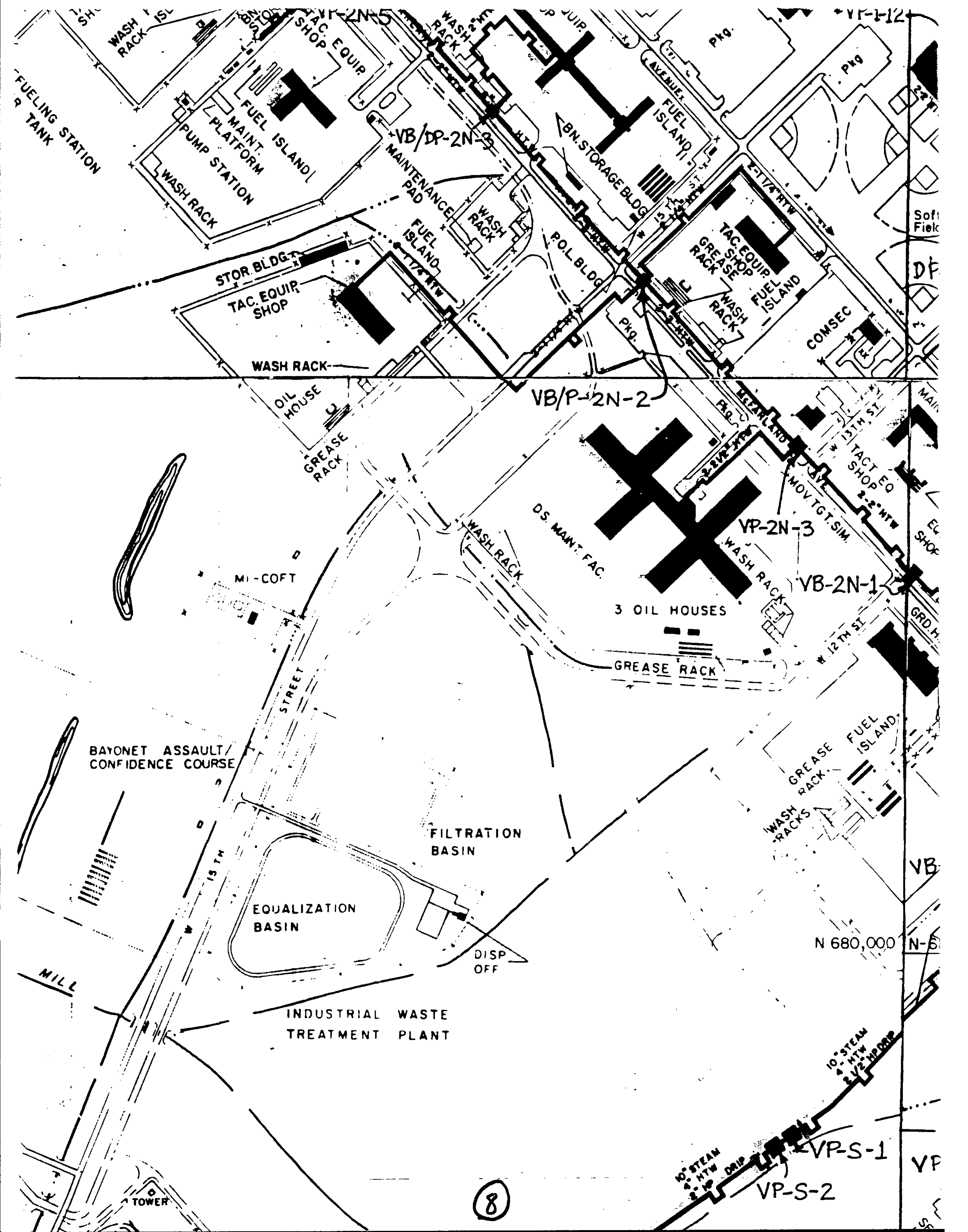
DAVIS
PG
HINESVILLE / FT. STEWART REGIONAL SEWAGE FACILITIES
WATER TOWER
HERO ROAD
Bike Path
PG.
Parking
ELEMENTARY SCHOOL
PG
YOUTH ACTIVITY CENTER
Football Field
30
COBB PL
OFFICERS FAMILY HOUSING
JOHNSTON PL
PG.
AVENUE
HODGES PL
MCINTOSH PL
GORDON PL
OGLETHORPE AVENUE
BROWN PL
PG
GREENE ST.
HARDEE PL
BROWN PL
WHEELER PL
GA. POWER SUB-STATION
PG.
MACKAY ST
BARTOW ST
BUS STOP
WHEELER AVE.
WHEELER PL
DEMERE ST
WATER STATION
AVENUE
PG
BUS STOP
HABERSHAM
ST.
PG.
7TH ST. N.
Baseb. Field
ANDERSON ST

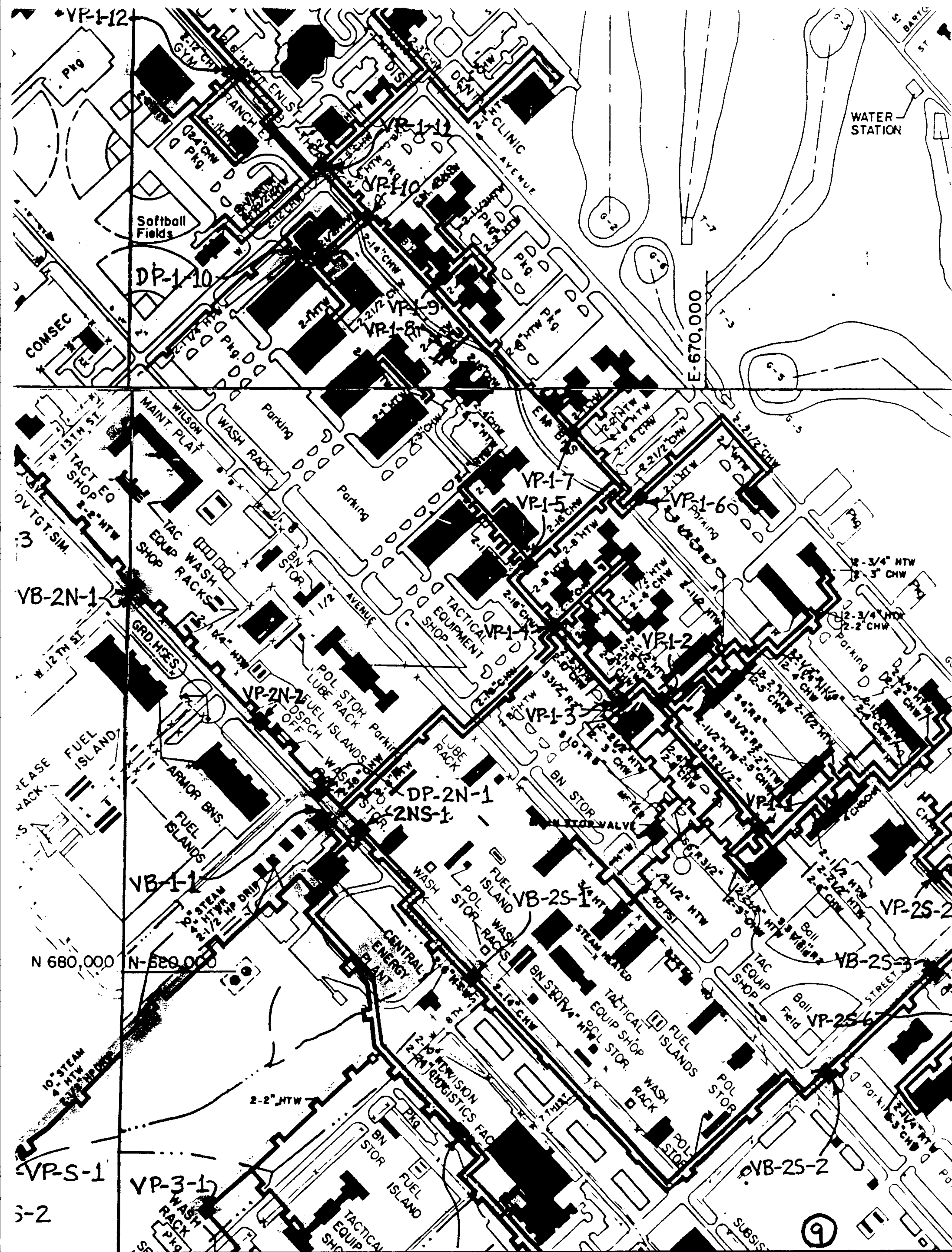

TANK TRAIL
LEG
S OR R 6" UT 100
HINESVILLE / FT. STEWART REGIONAL SEWAGE FACILITIES
TANK TRAIL
WASH RACK
CENTRAL DRAINAGE CANAL
FRENCH ROAD
Baseball Field
B.O.Q.
400
0
SCA
CONTOU


LEGEND
STEAM SUPPLY & RETURN
S OR R 6" UT 100
STEAM PRESSURE
TYPE CONSTRUCTION
SIZE
SUPPLY OR RETURN
MANHOLE & VALVE
EXPANSION LOOP
MANHOLE WITH EXPANSION JOINT
HIGH TEMP. & CHILLED WATER-SUPPLY & RETURN LINE WITH VALVE PIT
TYPE CONSTRUCTION
C-CONCRETE
I-INSULATING CONCRETE
M-METAL CONDUIT
A-ABOVE GROUND
O-OVERHEAD
T-TUNNEL
U-UNDERGROUND
N
400 0 400 800 1200
SCALE IN FEET
CONTOUR INTERVAL = 2'
WASH RACK
FRENCH ROAD
Parking

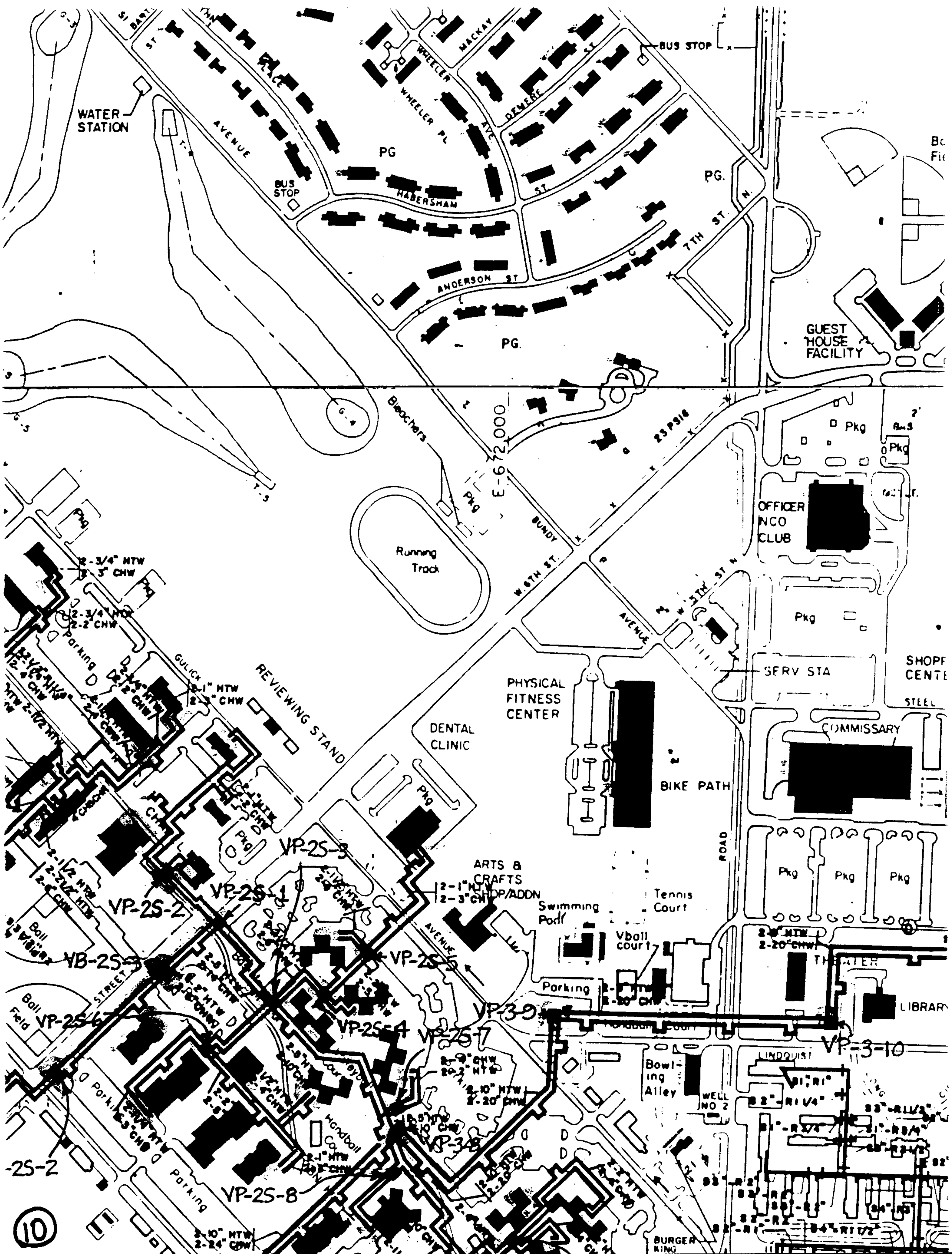


ANK
STATION
REFUELING STATION
WATER TANK
WASH RACK
CREEK
E 664,000
E 664,000
BAYONET
CONFIDENC
MILL
STORAGE BLDG
TACTICAL EQUIPMENT SHOP
VP-S-13
WASHRACK
PKG
SENTRY STATION
STORAGE BLDG
POL STORAGE BLDG
TOWER
7

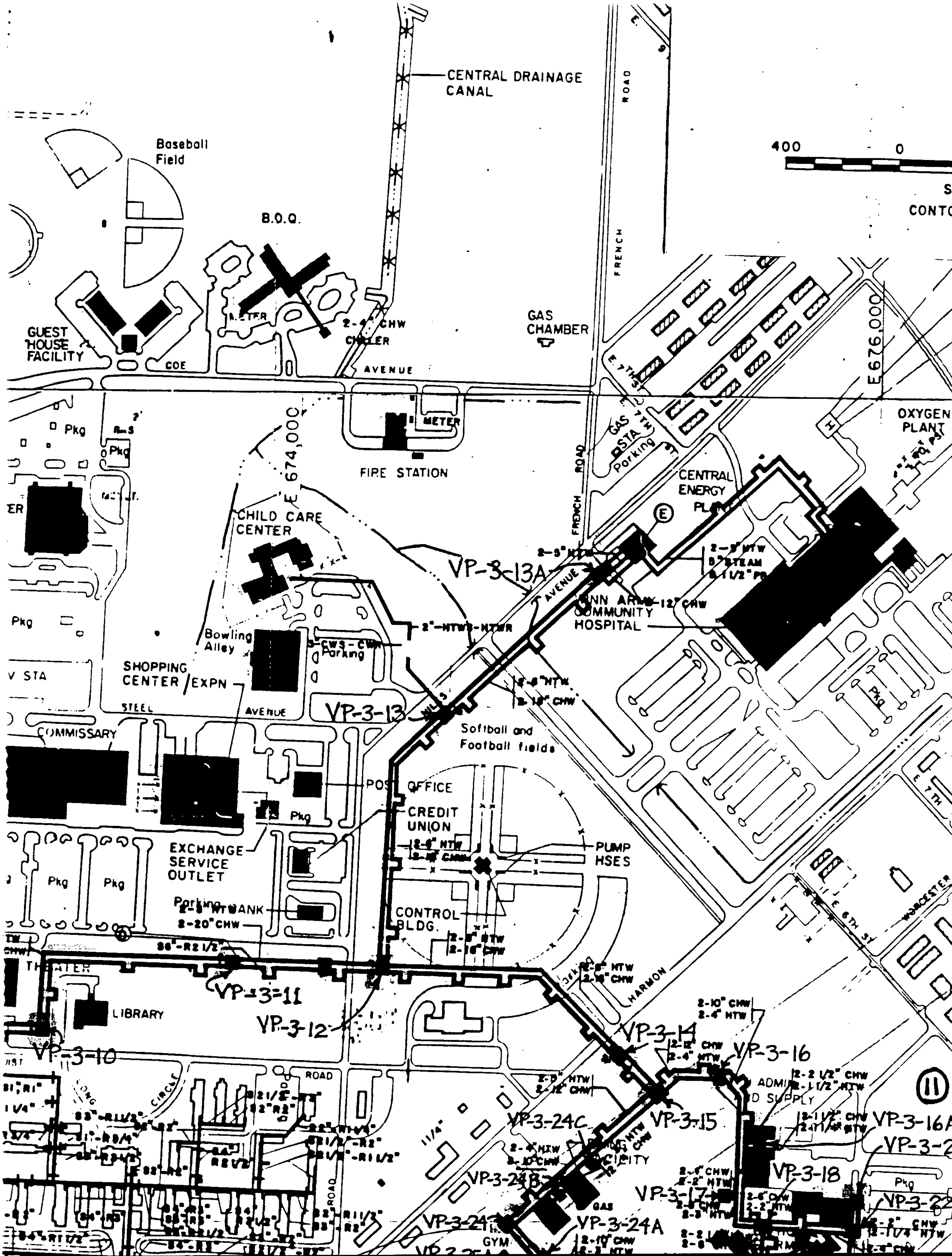

VP-2N-5
VP-1-12
WASH RACK
TAC. SHOP EQUIP
FUELING STATION
TANK
FUEL ISLAND
MAINT. PLATFORM
PUMP STATION
WASH RACK
Pkg.
AVENUE
FUEL ISLAND
BN. STORAGE BLDG.
VB/DP-2N-3
MAINTENANCE PAD
WASH RACK
FUEL ISLAND
P.O.L. BLDG.
STOR. BLDG.
TAC. EQUIP. SHOP
TAC. EQUIP. SHOP
GREASE RACK
FUEL ISLAND
WASH RACK
COMSEC
Pkg.
WASH RACK
VB/P-2N-2
OIL HOUSE
GREASE RACK
McFARLAND
W 13TH ST.
TACT EQ SHOP
MOV. TGT. SIM.
VP-2N-3
DS. MAINT. FAC.
WASH RACK
WASH RACK
VB-2N-1
MI-COFT
3 OIL HOUSES
GREASE RACK
W 12TH ST
STREET
BAYONET ASSAULT/ CONFIDENCE COURSE
GREASE RACK
FUEL ISLAND
WASH RACKS
FILTRATION BASIN
15TH
EQUALIZATION BASIN
DISP OFF
N 680,000
MILL
INDUSTRIAL WASTE TREATMENT PLANT
10" STEAM 4" HTW 2 1/2" HP DRIP
VP-S-1
VP-S-2
TOWER



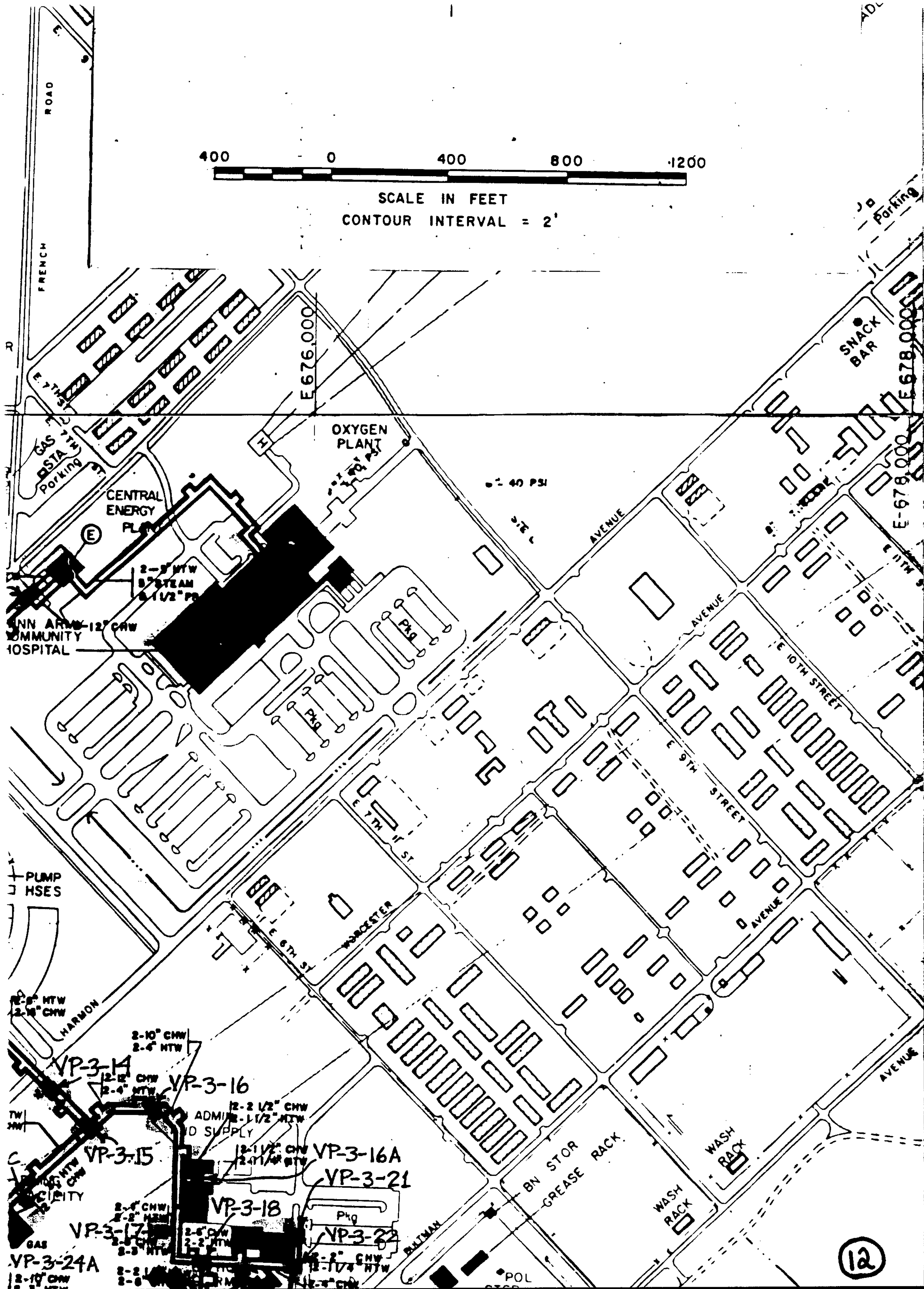
VP-1-12
GYM
ENLST
BRANCH EX
DIS
DENT
CLINIC
AVENUE
WATER STATION
VP-1-11
VP-1-10
Softball Fields
DP-1-10
COMSEC
VP-1-9
VP-1-8
E-670,000
Pkg.
Parking
WILSON
MAINT. PLAT
WASH RACK
W 13TH ST.
TACT EQ SHOP
VP-1-7
VP-1-5
VP-1-6
TAC EQUIP WASH SHOP RACKS
BN STOR
VB-2N-1
TACTICAL EQUIPMENT SHOP
VP-1-4
VP-1-2
W 12TH ST
GRD. HSES.
POL STOR LUBE RACK
VP-2N-2
FUEL ISLANDS
DSPCH OFF
FUEL ISLAND
ARMOR BNS.
VP-1-3
LUBE RACK
BN STOR
DP-2N-1
2NS-1
FUEL ISLANDS
VP-1-1
VB-1-1
WASH
POL STOR
FUEL ISLAND
VB-2S-1
WASH RACKS
CENTRAL ENERGY PLANT
STEAM HEATED
BN STOR
TACTICAL EQUIP SHOP
POL STOR
FUEL ISLANDS
TAC EQUIP SHOP
Ball Field
VB-2S-3
VP-2S-2
VP-2S-6
STREET
N 680,000
N-680,000
DIVISION LOGISTICS FAC
WASH RACK
POL STOR
BN STOR
FUEL ISLAND
VP-S-1
VP-3-1
WASH RACK
TACTICAL EQUIP SHOP
VB-2S-2
2-2" HTW
10" STEAM 4" HTW 2-1/2 HP DRIP
9



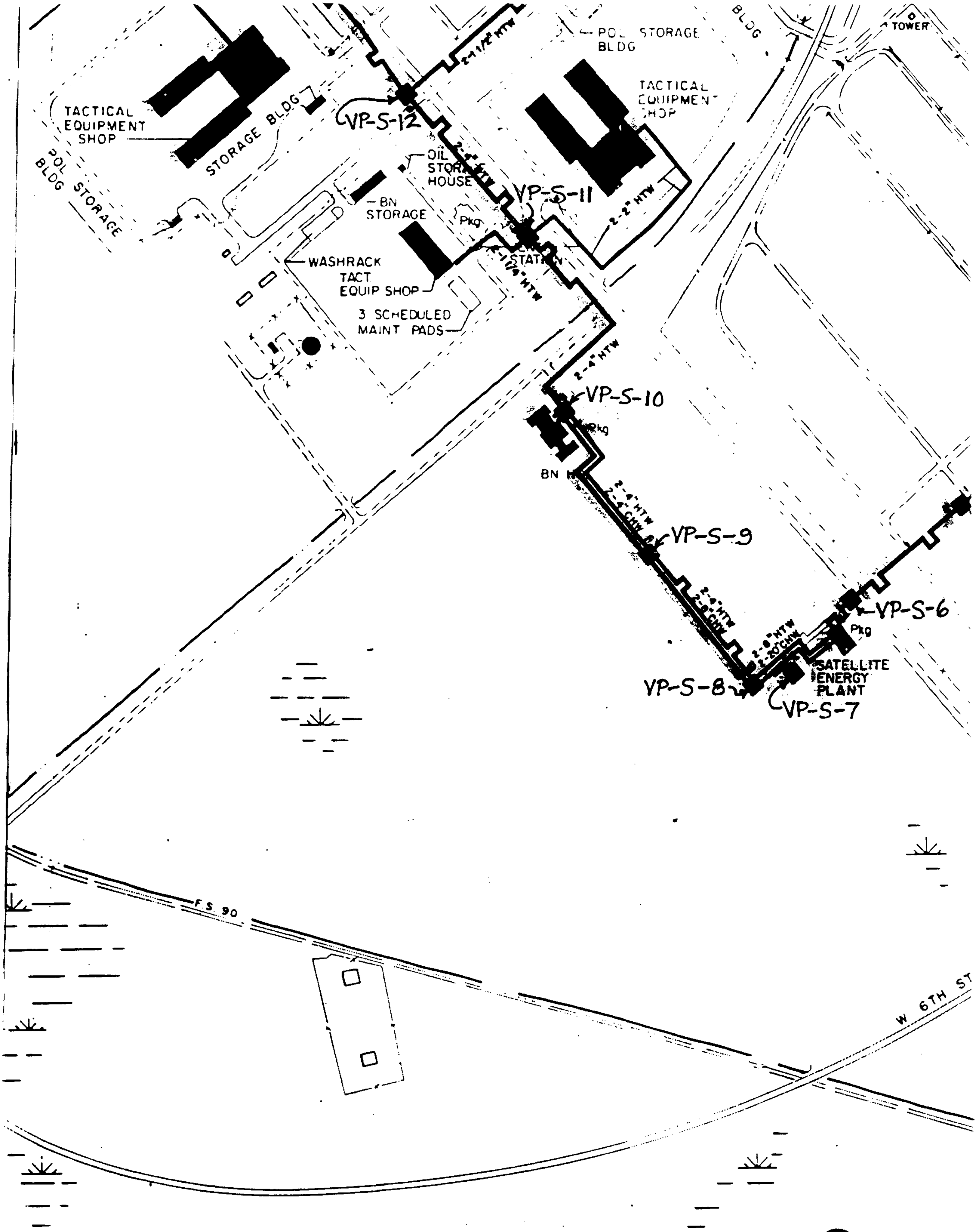
WATER STATION
BUS STOP
BUS STOP
PG
PG.
PG.
WHEELER
WHEELER PL
WHEELER AVE.
MACKAY
DEMERE ST
HABERSHAM
ST.
7TH ST. N.
ANDERSON ST
AVENUE
GUEST HOUSE FACILITY
Bleachers
Running Track
Pkg
E-6 2,000
23 PSIG
BUNDY
W. 6TH ST.
W. 5TH ST N
AVENUE
OFFICER NCO CLUB
Pkg
SERV STA
SHOPP CENTE
PHYSICAL FITNESS CENTER
BIKE PATH
COMMISSARY
DENTAL CLINIC
REVIEWING STAND
GULICK
Parking
2-3/4" HTW
2-3" CHW
2-3/4" HTW
2-2" CHW
2-1" HTW
2-3" CHW
ROAD
Pkg
Pkg
Pkg
ARTS & CRAFTS SHOP/ADDN
2-1" HTW
2-3" CHW
Swimming Pool
Tennis Court
Vball court
Parking
THEATER
LIBRARY
2-8" HTW
2-20" CHW
VP-2S-3
VP-2S-1
VP-2S-2
VB-2S-3
VP-2S-5
VP-2S-6
VP-2S-4
VP-2S-7
VP-3-9
VP-3-10
VP-3-8
VP-2S-8
-2S-2
STREET
Ball Field
Ball
Parking
Parking
Handball Court
Bowling Alley
WELL NO 2
LINDQUIST
2-9" CHW
2-2" HTW
2-10" HTW
2-20" CHW
2-10" HTW
2-24" CHW
BURGER KING
(10)



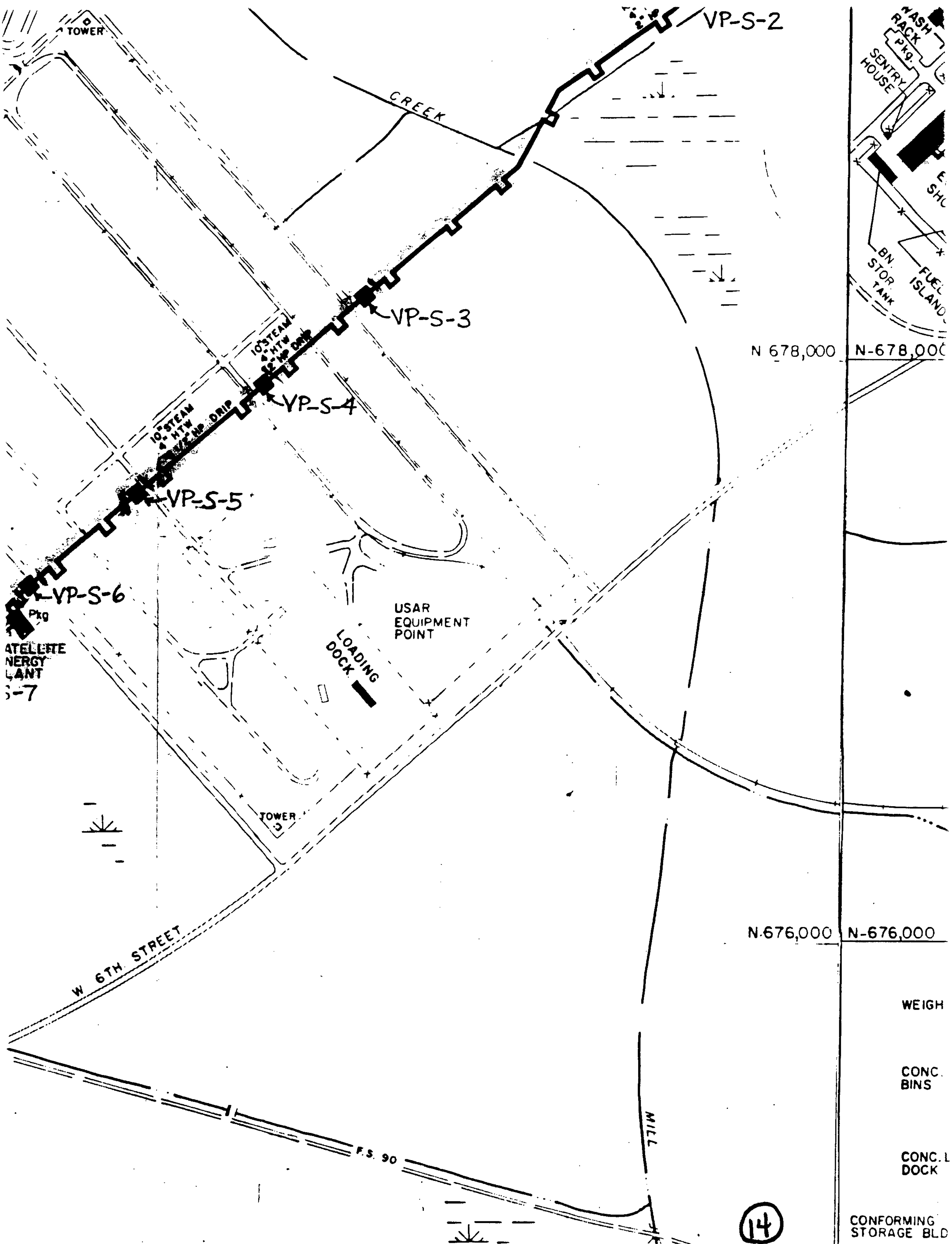
CENTRAL DRAINAGE CANAL
ROAD
400
0
SC
CONTO
Baseball Field
B.O.Q.
GUEST HOUSE FACILITY
COE
AVENUE
CHILLER
GAS CHAMBER
FRENCH
E 676,000
OXYGEN PLANT
METER
FIRE STATION
E 674,000
Pkg
GAS STA
Parking
CENTRAL ENERGY PLANT
CHILD CARE CENTER
VP-3-13A
2-5" HTW
5" STEAM
ARMY COMMUNITY HOSPITAL
12" CHW
Bowling Alley
2"-HTWS-HTWR
SHOPPING CENTER / EXPN
STEEL
AVENUE
VP-3-13
Softball and Football fields
COMMISSARY
POST OFFICE
CREDIT UNION
EXCHANGE SERVICE OUTLET
PUMP HSES
Pkg
BANK
2-20" CHW
CONTROL BLDG.
THEATER
VP-3-11
LIBRARY
HARMON
VP-3-12
VP-3-10
VP-3-14
2-10" CHW
2-4" HTW
VP-3-16
VP-3-15
CIRCLE
ROAD
ADMIN
SUPPLY
11
VP-3-24C
VP-3-16A
VP-3-18
VP-3-24B
VP-3-17
VP-3-24
VP-3-24A
GAS
GYM
VP-3-22
E 6TH ST
WORCESTER



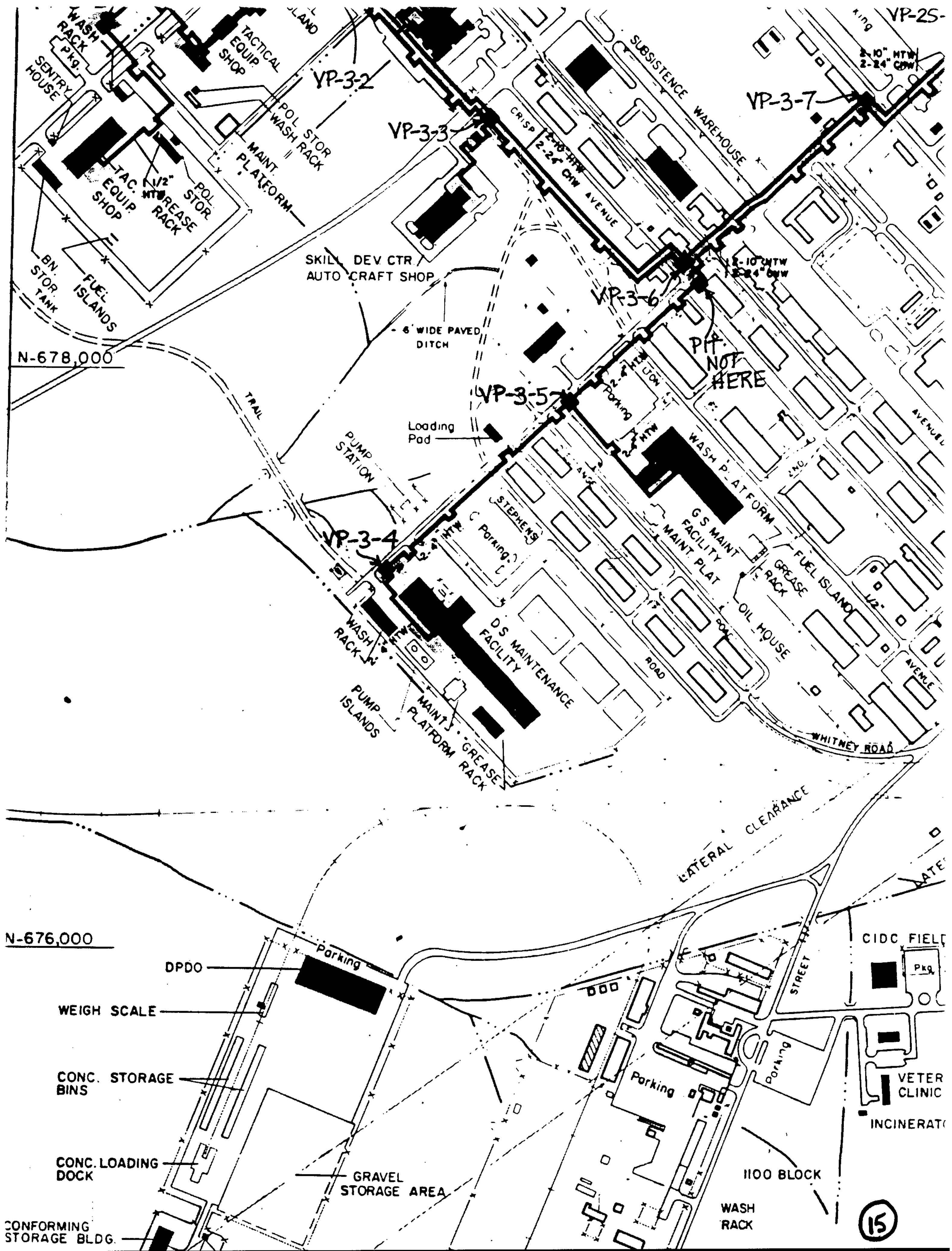
400 0 400 800 1200
SCALE IN FEET
CONTOUR INTERVAL = 2'
ROAD
FRENCH
E 676,000
E 678,000
E-678,000
OXYGEN PLANT
CENTRAL ENERGY PLANT
GAS STA
Parking
SNACK BAR
AVENUE
E 10TH STREET
E 9TH STREET
E 7TH ST
E 6TH ST
WORCESTER
HARMON
PUMP HSES
HOSPITAL
Pkg
2-10" CHW
2-4" HTW
VP-3-14
VP-3-16
VP-3-15
VP-3-16A
VP-3-21
VP-3-18
VP-3-17
VP-3-22
VP-3-24A
ADMIN AND SUPPLY
BN STOR
GREASE RACK
WASH RACK
POL
PULTMAN
12



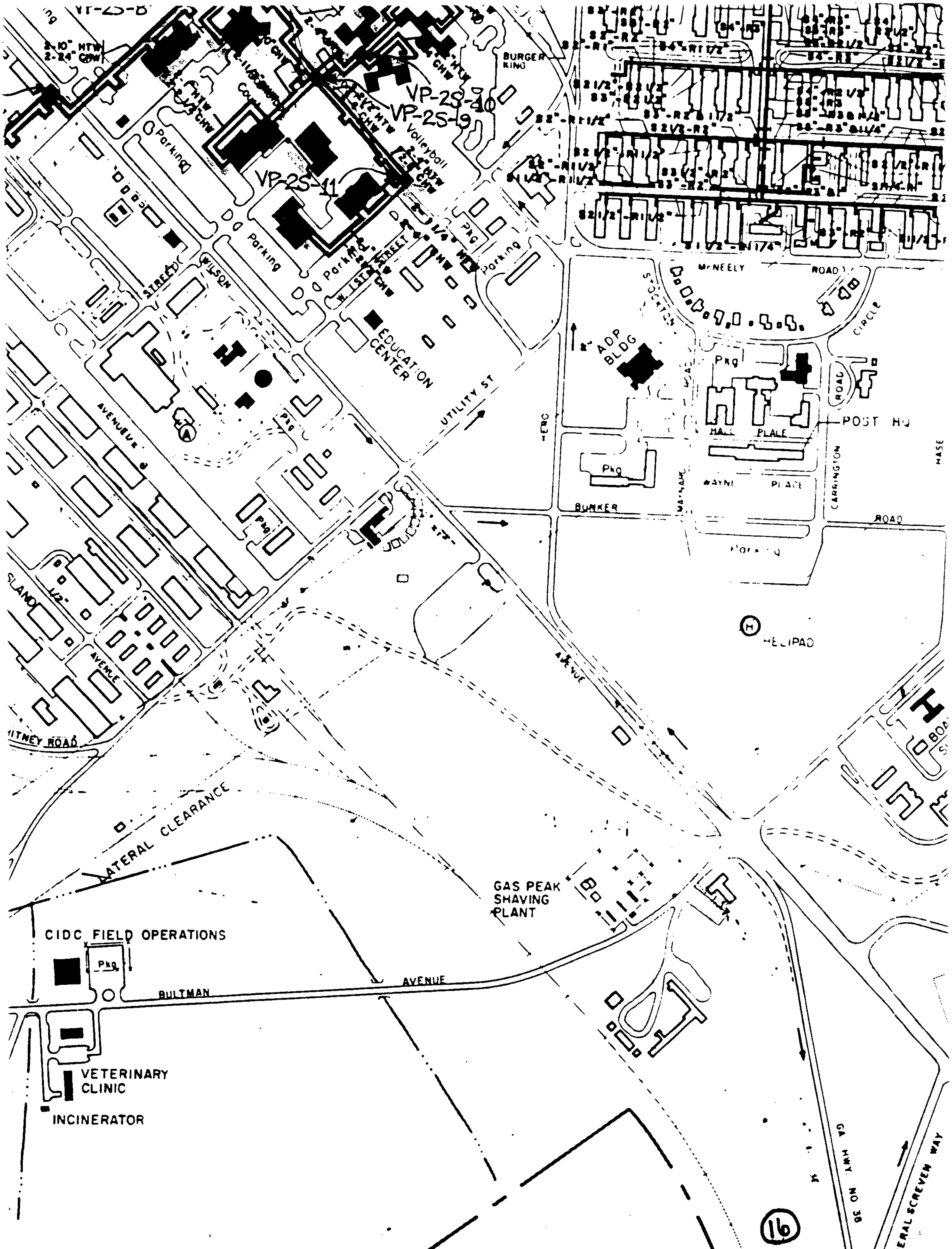
TACTICAL EQUIPMENT SHOP
STORAGE BLDG
POL STORAGE BLDG
VP-S-12
2-1 1/2" HTW
POL STORAGE BLDG
TOWER
TACTICAL EQUIPMENT SHOP
OIL STORAGE HOUSE
BN STORAGE
Pkg
VP-S-11
2-2" HTW
WASHRACK
TACT EQUIP SHOP
STATION
3 SCHEDULED MAINT PADS
2-4" HTW
VP-S-10
Pkg
BN HQ
2-4" HTW
VP-S-9
2-4" HTW
VP-S-6
Pkg
SATELLITE ENERGY PLANT
VP-S-8
VP-S-7
F.S. 90
W 6TH ST



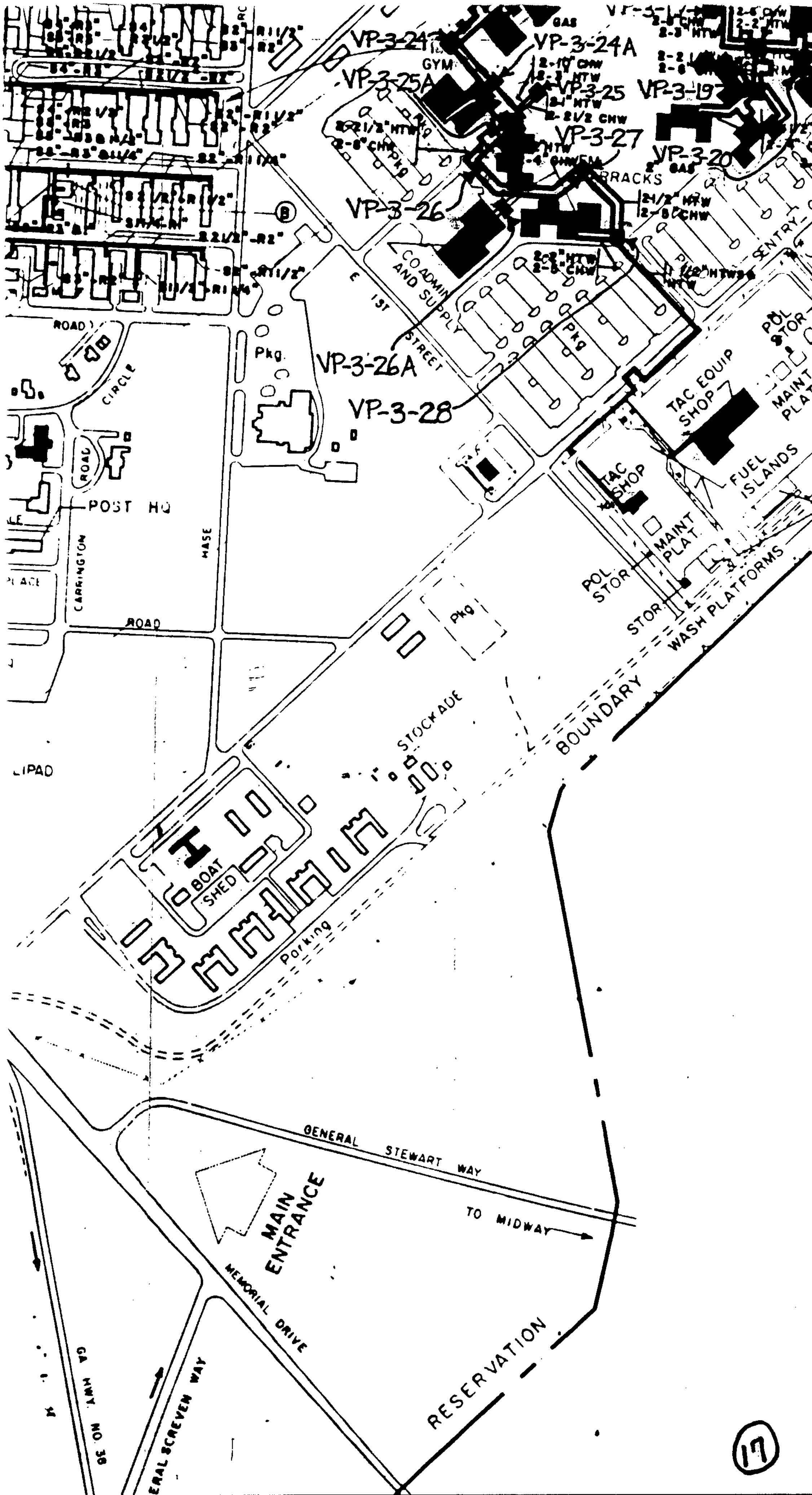
VP-S-2
TOWER
CREEK
WASH RACK
Pkg.
SENTRY HOUSE
BN. STOR TANK
FUEL ISLAND
VP-S-3
10" STEAM 4" HTW 1½" HP DRIP
VP-S-4
10" STEAM 4" HTW 1½" HP DRIP
VP-S-5
VP-S-6
Pkg
ATELLITE NERGY LANT
-7
N 678,000
N-678,00
USAR EQUIPMENT POINT
LOADING DOCK
TOWER
W 6TH STREET
N-676,000
N-676,000
WEIGH
CONC. BINS
F.S. 90
MILL
CONC. DOCK
CONFORMING STORAGE BLD



WASH RACK
Pkg.
SENTRY HOUSE
TACTICAL EQUIP SHOP
TAC. EQUIP. SHOP
1/2" HTW
GREASE RACK
POL STOR
BN. STOR TANK
FUEL ISLANDS
VP-3-2
POL STOR WASH RACK
MAINT PLATFORM
VP-3-3
CRISP AVENUE
2-10" HTW
2-24" CHW
SUBSISTENCE WAREHOUSE
VP-25-
VP-3-7
SKILL DEV CTR
AUTO CRAFT SHOP
6' WIDE PAVED DITCH
N-678,000
TRAIL
VP-3-6
PIT NOT HERE
VP-3-5
Parking
Loading Pad
PUMP STATION
WASH PLATFORM
G S MAINT FACILITY
MAINT PLAT
GREASE RACK
FUEL ISLAND
OIL HOUSE
VP-3-4
STEPHENS
DS MAINTENANCE FACILITY
WASH RACK
PUMP ISLANDS
MAINT PLATFORM
GREASE RACK
ROAD
AVENUE
WHITNEY ROAD
LATERAL CLEARANCE
N-676,000
Parking
DPDO
WEIGH SCALE
CONC. STORAGE BINS
CONC. LOADING DOCK
GRAVEL STORAGE AREA
CONFORMING STORAGE BLDG.
STREET
CIDC FIELD
Pkg
VETER CLINIC
INCINERAT
1100 BLOCK
WASH RACK



BURGER KING
VP-2S-10
VP-2S-9
VP-2S-11
Volleyball
Parking
STREET
WILSON
W. 1ST STREET
EDUCATION CENTER
UTILITY ST
AVENUE
Pkg
ADP BLDG
McNEELY ROAD
STOCKTON
CIRCLE
POST HQ
BUNKER ROAD
CARRINGTON
WAYNE PLACE
HELIPAD
LATERAL CLEARANCE
GAS PEAK SHAVING PLANT
CIDC FIELD OPERATIONS
BULTMAN AVENUE
VETERINARY CLINIC
INCINERATOR
GA HWY NO 38




# FORT STEWART

## SURVEY

PHASE I - CEP, SEF

PHASE II - VALVE &

PHASE III - DISTRIBU
ZONE 1
ZONE 2
ZONE 3
SEP DIS

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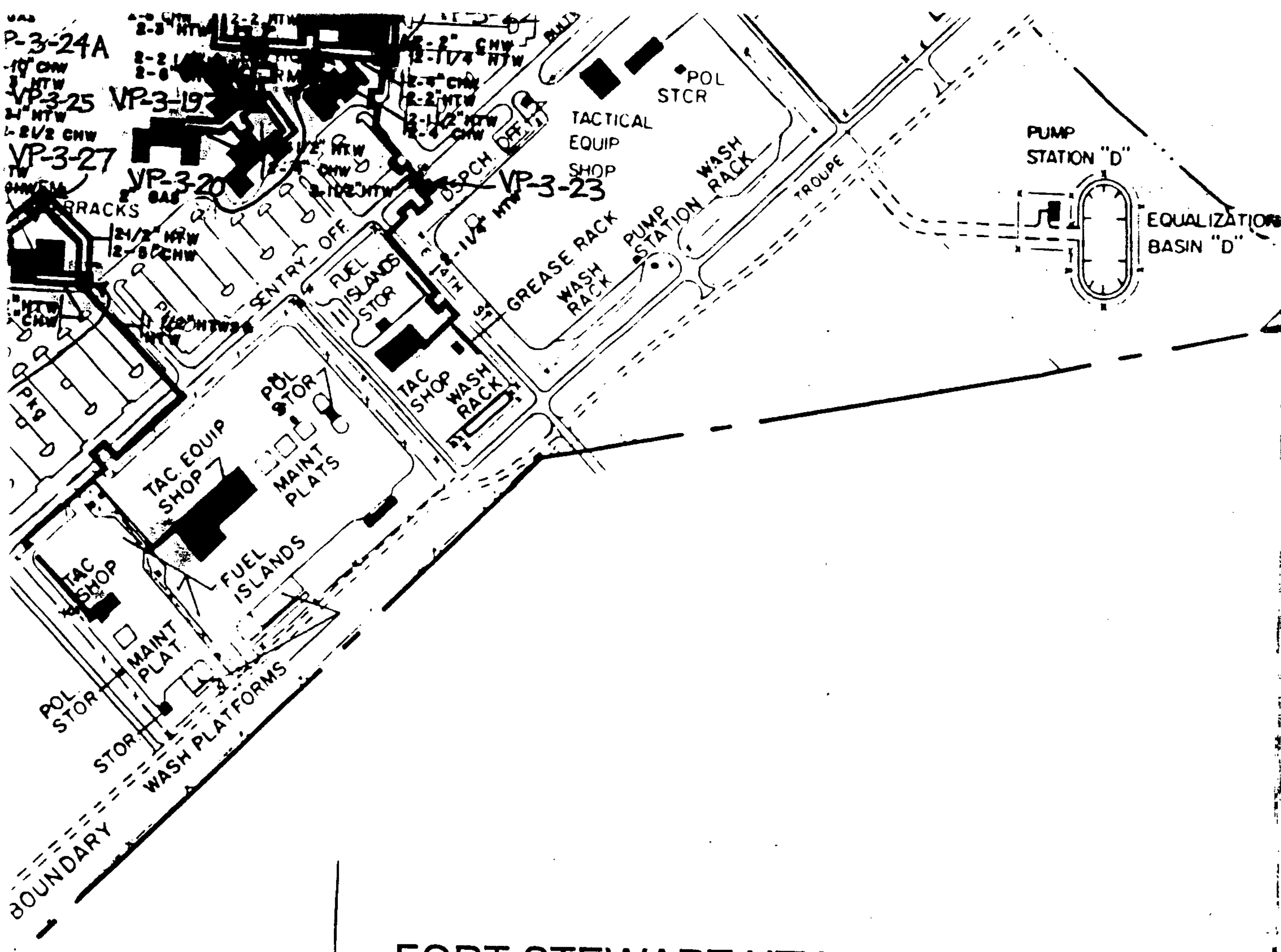
Architectural, Engineering, Planning




# FORT STEWART HTW SYSTEM

## SURVEY PLAN

PHASE I - CEP, SEP & MECH. RMS

PHASE II - VALVE & DRAIN PITS

PHASE III - DISTRIBUTION SYSTEMS
ZONE 1 DIST. SYSTEM
ZONE 2 DIST. SYSTEM
ZONE 3 DIST. SYSTEM
SEP DISTRIB. SYSTEM

RS&H

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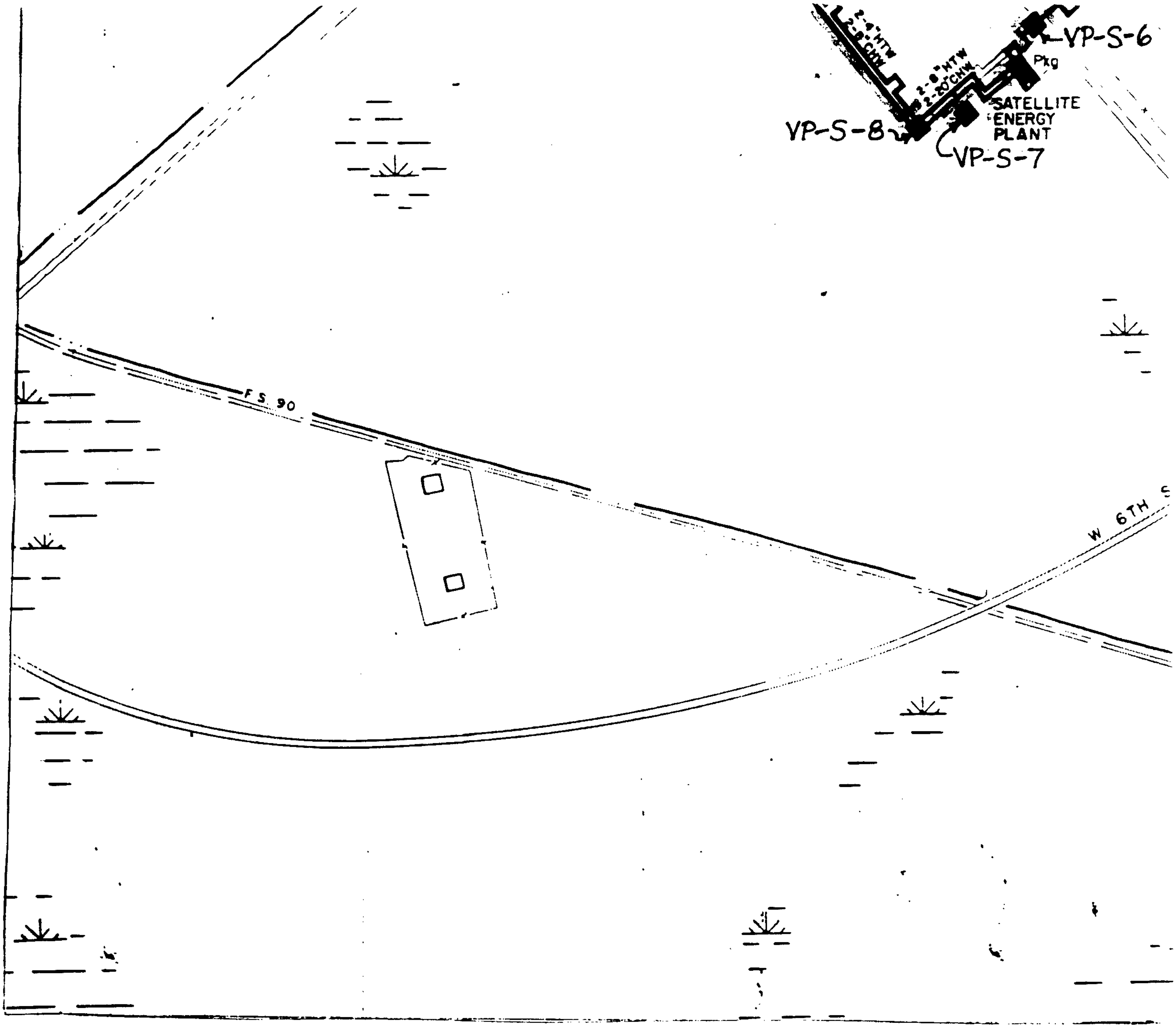
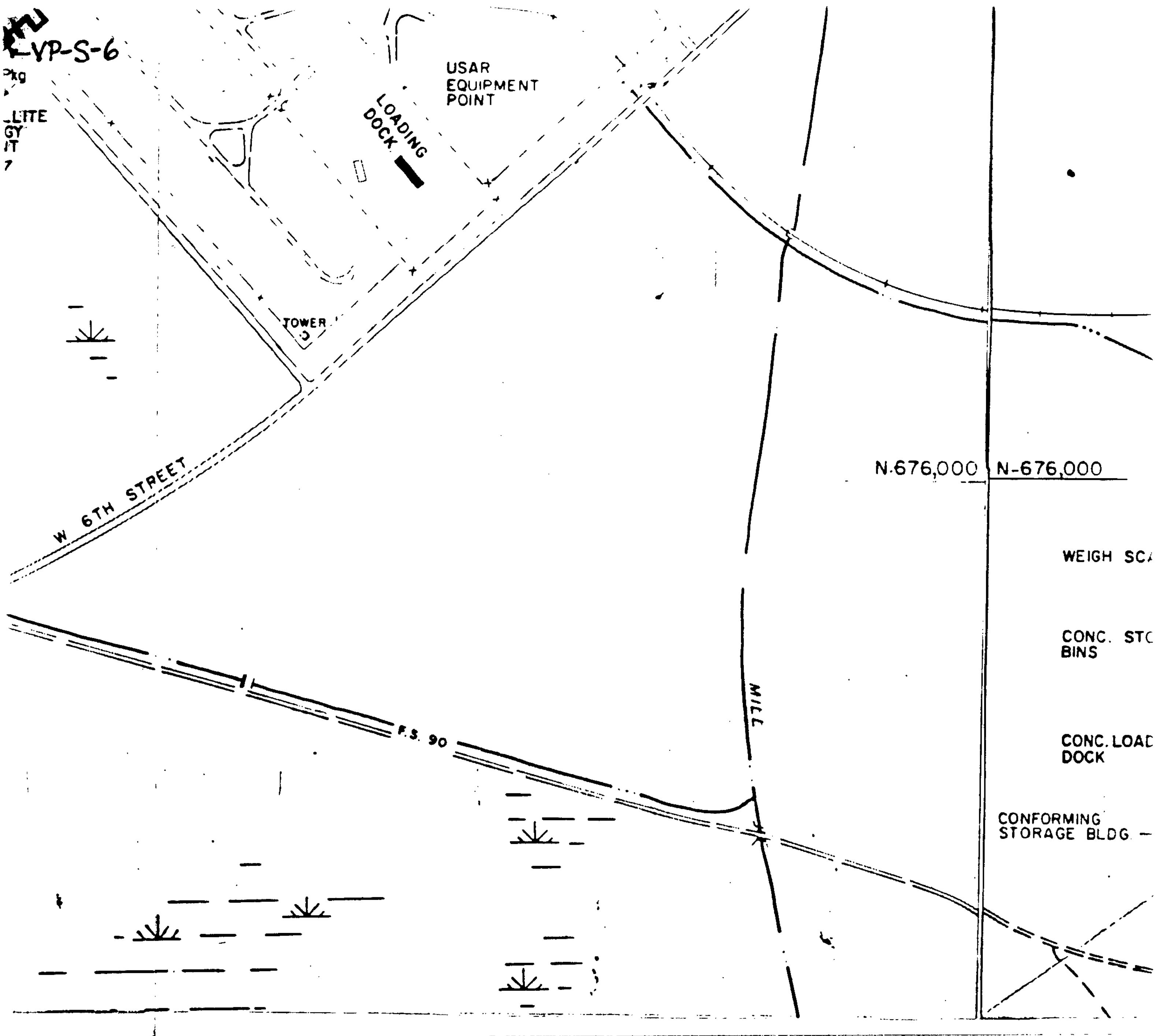
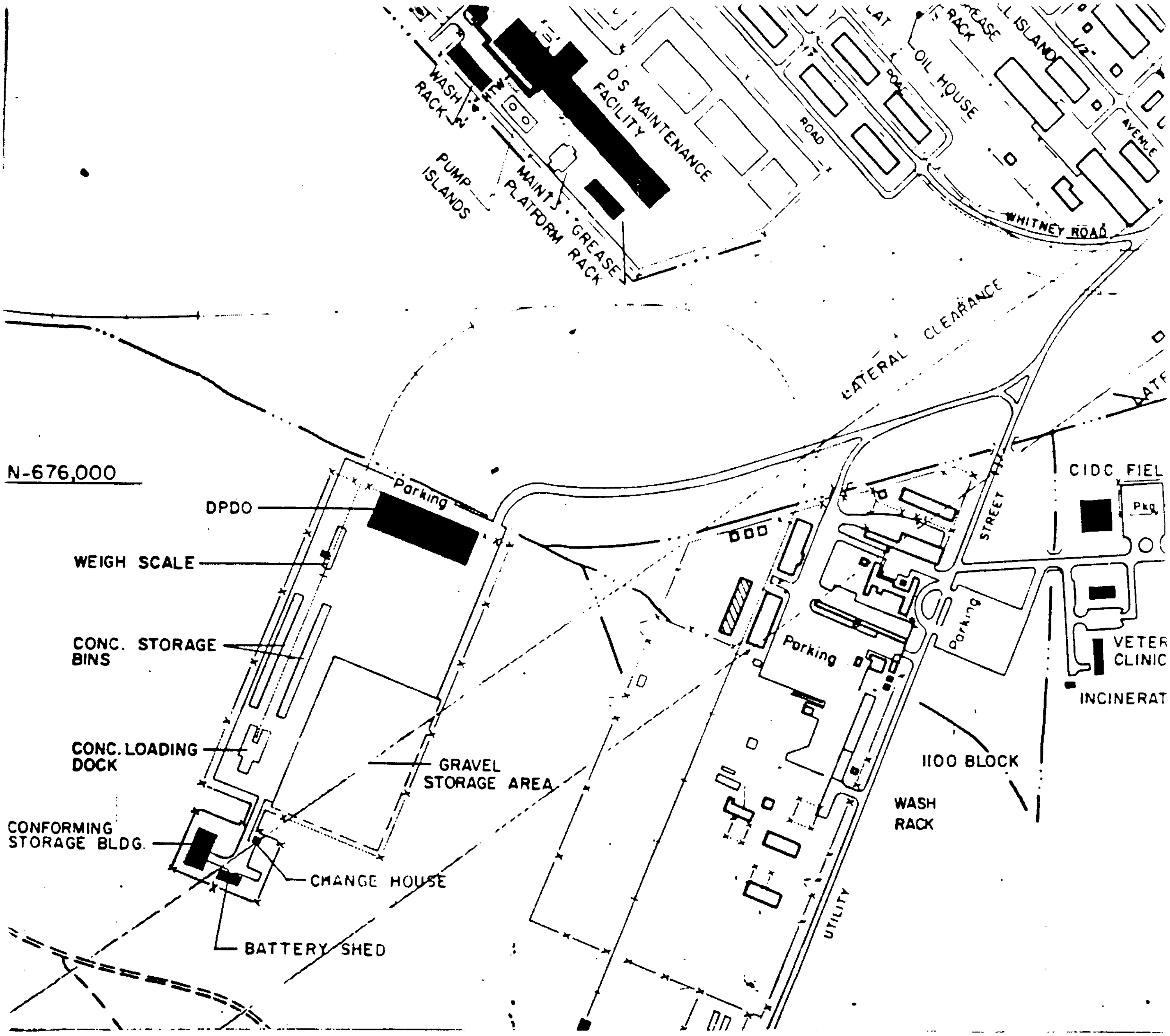
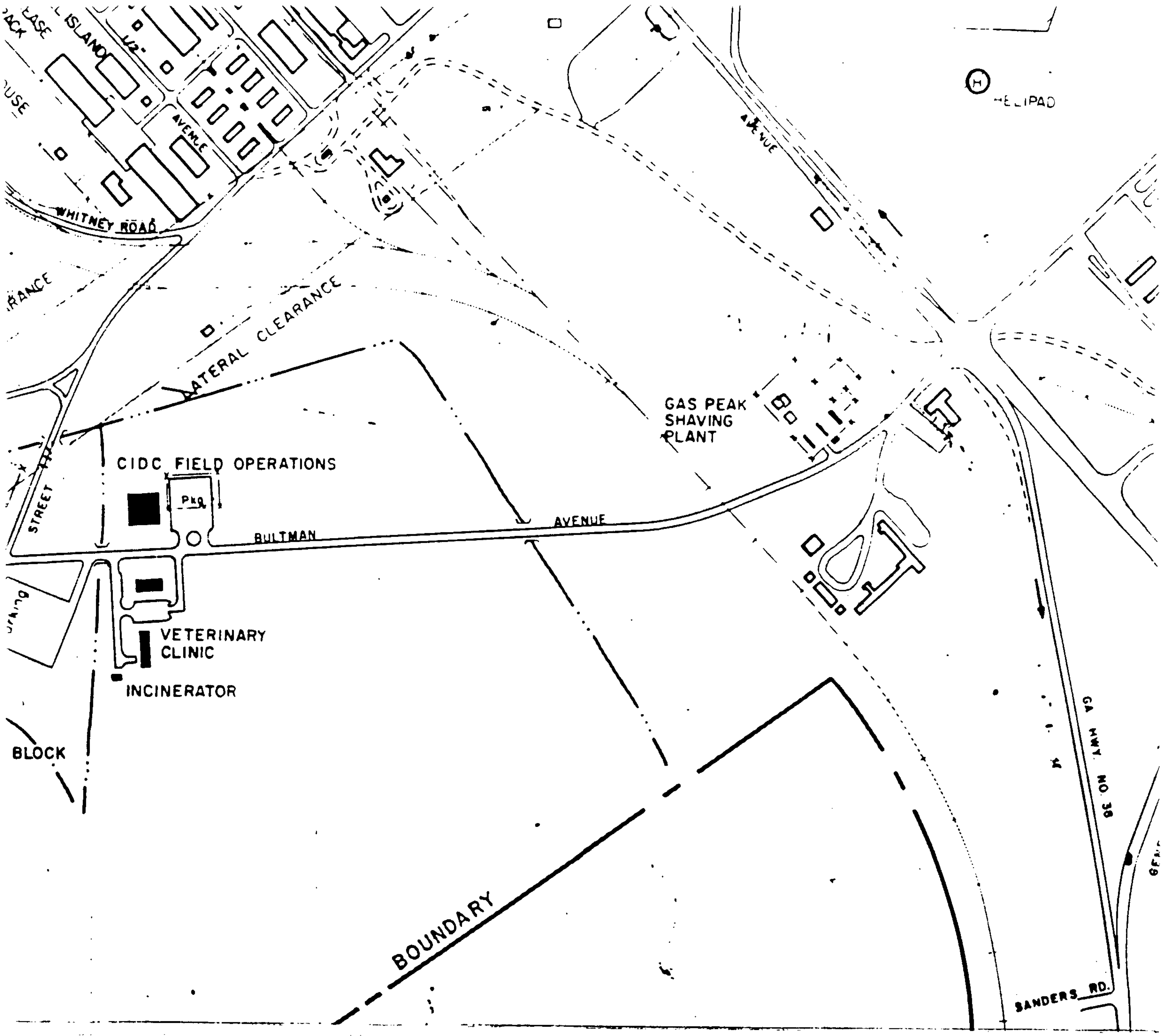
Architectural, Engineering, Planning and Environmental Services


VP-S-6
Pkg
SATELLITE ENERGY PLANT
VP-S-8
VP-S-7
2-8" HTW
2-20" CHW
F S 90
W 6TH S

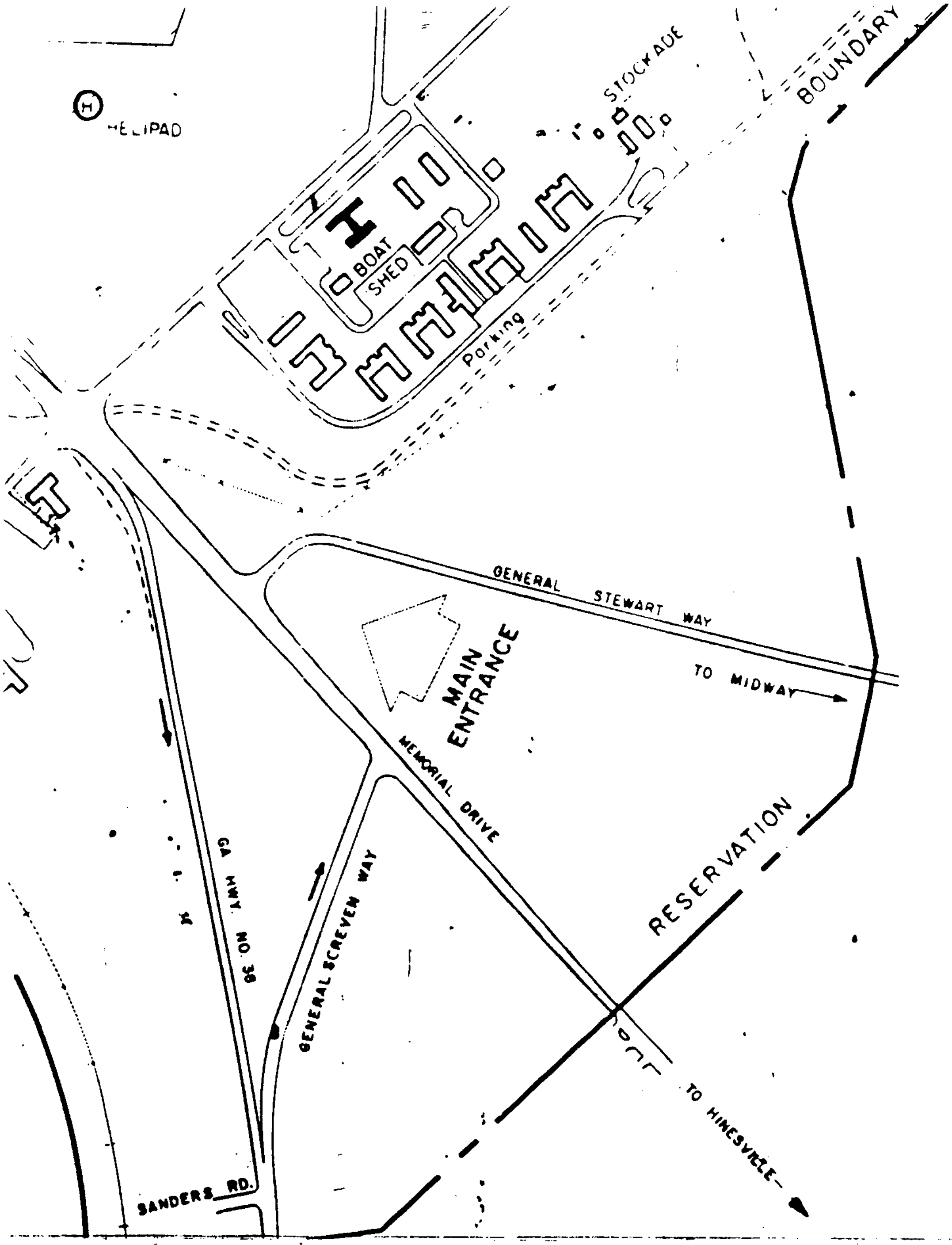

VP-S-6
Pkg
LLITE
GY
IT
USAR
EQUIPMENT
POINT
LOADING
DOCK
TOWER
W 6TH STREET
N-676,000
N-676,000
WEIGH SC
CONC. STC
BINS
MILL
F.S. 90
CONC. LOAD
DOCK
CONFORMING
STORAGE BLDG.
20



WASH RACK
PUMP ISLANDS
MAINT. PLATFORM
GREASE RACK
DS MAINTENANCE FACILITY
ROAD
OIL HOUSE
WHITNEY ROAD
LATERAL CLEARANCE
N-676,000
DPDO
Parking
WEIGH SCALE
CONC. STORAGE BINS
CONC. LOADING DOCK
GRAVEL STORAGE AREA
CONFORMING STORAGE BLDG.
CHANGE HOUSE
BATTERY SHED
Parking
STREET
CIDC FIEL
Pkg
Parking
VETER CLINIC
INCINERAT
1100 BLOCK
WASH RACK
UTILITY



HELIPAD
AVENUE
WHITNEY ROAD
LATERAL CLEARANCE
GAS PEAK
SHAVING
PLANT
CIDC FIELD OPERATIONS
Pkg
STREET
BULTMAN
AVENUE
VETERINARY
CLINIC
INCINERATOR
BLOCK
BOUNDARY
GA HWY. NO. 38
SANDERS RD.




FORT STE

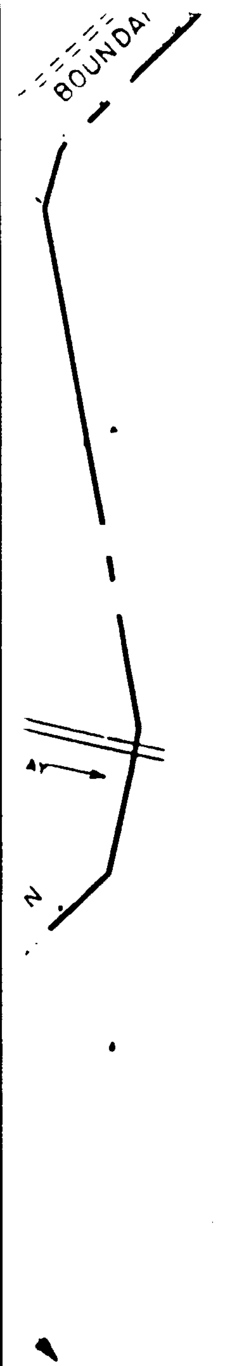
SU

PHASE I -

PHASE II -

PHASE III -

Reynolds, Smith anc
Architectural, Engine



# FORT STEWART HTW SYSTEM

## SURVEY PLAN

PHASE I - CEP, SEP & MECH. RMS ☐

PHASE II - VALVE & DRAIN PITS ☐

PHASE III - DISTRIBUTION SYSTEMS
- ZONE 1 DIST. SYSTEM ☐
- ZONE 2 DIST. SYSTEM ☐
- ZONE 3 DIST. SYSTEM ☐
- SEP DISTRIB. SYSTEM ☐

RS&H

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Architectural, Engineering, Planning and Environmental Services

# A.3 ECO ENERGY AND COST CALCULATIONS

## ECO NUMBER 1

## REPLACEMENT OF THE EXISTING HTW DISTRIBUTION LINES WITH A NEW SHALLOW TRENCH DISTRIBUTION SYSTEM

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-1
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-1 REPLACE THE HTW DISTRIBUTION SYSTEM
FISCAL YEAR 1995 DISCRETE PORTION NAME: SHALLOW TRENCH HTW PIPING
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 21975320. | | |
| B. SIOH | $ 1318519. | | |
| C. DESIGN COST | $ 1318519. | | |
| D. TOTAL COST (1A+1B+1C) | $ 24612360. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 24612360. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 7. | $ 89. | 15.08 | $ 1347. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 177890. | $ 238373. | 14.88 | $ 3546985. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 177897. | $ 238462. | | $ 3548331. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 8857.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 131792.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 131792.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 247319.

5. SIMPLE PAYBACK PERIOD (1G/4) 99.52 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 3680124.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= .15
(IF < 1 PROJECT DOES NOT QUALIFY)

## ECO Number 1

Replacement of the existing HTW distribution lines with a new shallow trench distribution system.

**Description**

This project consists of replacing the existing underground HTW piping system with a new shallow trench distribution system. The existing HTW piping could be demolished and removed or it could be abandoned in place. The cost estimate and economic analysis assumes the existing HTW piping will be removed and sold for scrap. The new HTW piping design call for Schedule 80 steel pipe with welded joints. The new HTW pipe will be insulated with calcium silicate, installed inside a metal conduit and positioned in a shallow trench.

**Analysis**

This project is specifically called for by the scope of work, however, our surveys and analysis have indicated that the losses due to HTW leaks from the underground distribution system average only about 2.53 GPM which is 1,329,800 gallons per year. These losses are low considering the length and age of the piping system. However, there are substantial heating energy losses due to deteriorated and moist insulation.

Light steam flow and dripping was observed at many of the HTW conduit vent pipes during the valve pit survey. Since the estimated leaks in the HTW system were so low, it was assumed that the steam was being produced by ground water leaking into the HTW conduit. The conductivity of the insulation will increase dramatically with the introduction of moisture. A study of buried pipes for the district heating system at Fort McClellan estimated the heat transfer rates to be 55 Btu/Hr•LF for dry, insulated buried pipes and 275 Btu/Hr•LF for buried pipes with entrapped moisture and deteriorated insulation. The energy savings calculations assume that approximately one-half of the total length of HTW piping at Fort Stewart has deteriorated and moist insulation.

A small amount of energy and water savings are achieved by reducing the HTW losses from 2.53 GPM to approximately 0.10 GPM. The savings calculations and economic analysis assume an average of two leaks in the HTW piping each year and an average HTW loss of 20,000 gallons per leak.

The operation and maintenance savings associated with the need to repair about two HTW leaks per year is included in the economic analysis. The operation and maintenance cost includes trench excavation, HTW pipe repair and backfilling of the trench. Lengths and sizes of HTW piping used for energy savings calculations and cost estimates were taken from drawings titled Fort Stewart Central Heating and Cooling - Existing Conditions.

# ECO-1 REPLACE HTW PIPING

## Heat Loss from Buried Pipe

Assumptions:

1) Total length of supply and return pipe = 122 000 LF
2) About 1/2 of the piping has deteriorated insulation and entrapped moisture.
3) Average HTW pipe diameter is 6"
4) Average HTW supply temp. = 350 °F
5) Average HTW return temp. = 200 °F
6) HTW pipes have 4" of calcium silicate insulation
7) Heat loss from dry, insulated, buried pipes is about 55 Btu/HR·LF (see #9)
8) Heat loss from buried pipes with entrapped moisture and deteriorated insulation is 275 Btu/HR·LF (see #9)
9) Source is Ft. McClellan Study, see attached pages
10) Average ground temperature ≈ 70°F
11) Average boiler efficiency 68 percent

## Current Heat Loss:

$$122\,000 \text{ LF} \times 0.5 \times 55 \ \text{Btu}/\text{HR}\cdot\text{LF} \times \frac{1 \text{ mBtu}}{10^6 \text{ Btu}} = 3.355 \ \text{mBtu}/\text{HR}$$

$$122\,000 \text{ LF} \times 0.5 \times 275 \ \text{Btu}/\text{HR}\cdot\text{LF} \times \frac{1 \text{ mBtu}}{10^6 \text{ Btu}} = 16.775 \ \text{mBtu}/\text{HR}$$

$$\text{Annual Heat Loss} = \left(3.355 \frac{\text{mBtu}}{\text{HR}} + 16.775 \frac{\text{mBtu}}{\text{HR}}\right) \times 8760 \frac{\text{HR}}{\text{YR}}$$

$$\text{Current annual heat loss} = 20.13 \frac{\text{mBtu}}{\text{HR}} \times 8760 \frac{\text{HR}}{\text{YR}} = 176340 \frac{\text{mBtu}}{\text{YR}}$$

$$\text{Current fuel use} = 176340 \frac{\text{mBtu}}{\text{YR}} \div 0.68 = \underline{259320 \frac{\text{mBtu}}{\text{YR}}}$$

ECO-1 REPLACE HTW PIPING

Heat Loss w/ New Piping System

$$122\,000 \text{ LF} \times 55 \frac{\text{Btu}}{\text{HR}\cdot\text{LF}} \times \frac{1 \text{ mBtu}}{10^6 \text{ Btu}} = 6.71 \text{ mBtu/HR}$$

$$\text{Annual heat loss} = 6.71 \frac{\text{mBtu}}{\text{HR}} \times 8760 \frac{\text{HR}}{\text{YR}} = 58780 \frac{\text{mBtu}}{\text{YR}}$$

$$\text{Current Fuel use} = 58780 \frac{\text{mBtu}}{\text{YR}} \div 0.68 = \underline{86{,}440 \frac{\text{mBtu}}{\text{YR}}}$$

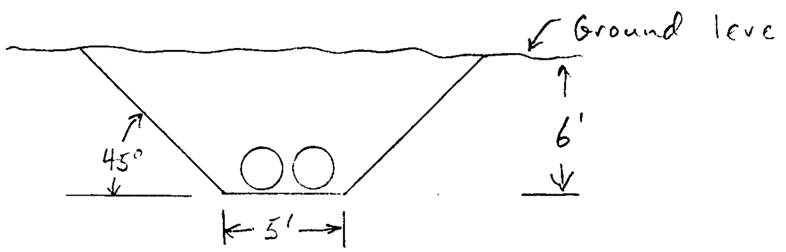
ECO-1 Replace HTW Piping
W/o Leak Correlator

Assume 1/3 of the distance between valve pits must be dug up before the leak is found.

Average distance between valve pits:

$$\frac{9100 \text{ lf} + 4600 \text{ lf} + 6700 \text{ lf} + 17400 \text{ lf} + 8750 \text{ lf}}{95 \text{ Valve Pits}} = 490 \text{ LF/pit}$$

Area of excavation: Assume




$6' \times 11' \times 490' \times \frac{1}{3} = 10780 \text{ cf} \div 27 \frac{\text{cf}}{\text{cy}} = 399 \Rightarrow 400 \text{ cy}$

Excavation : \$ 4.41 /cy × 400 cy = \$1764/leak (96MM p 28)
Backfill : \$(1.53 + 2.13)/cy × 400 cy = \$ 1464 /leak "
Repair : 3 men × 6 hrs × \$46.35/hr = 834/leak (96MM p 475)
Time Req'd : $400 \text{ cy} \times 0.080 \text{ hr/cy} \div 24 \frac{\text{hr}}{\text{day}} = 1.3 \frac{\text{days}}{\text{leak}}$ (96MM p 28)

O&M Costs = \$(1764 + 1464 + 834)/leak × 2 $\frac{\text{leaks}}{\text{yr}}$ = $\boxed{\$8124/\text{year}}$

HTW Lost : (See graph of 1995 Make-up water use)

Average loss during leak = 25000 GPD
Average 1995 Make-up use = 10000 GPD

(25000 GPD − 10000 GPD) × 1.3 Day/leak = 20,000 Gal/leak

**RS&H**

| | | | |
|---|---|---|---|
| SUBJECT | Fort Stewart | AEP NO | 694 1331 002 |
| | Replace HTW Piping | SHEET | 4 OF 4 |
| DESIGNER | W. Todd | DATE | 2-7-96 |
| CHECKER | | DATE | |

ECO-1 REPLACE HTW PIPING

Minor HTW leaks average 2.5 GPM (see table for calc)

$$2.53\ \text{GPM} \times 1440\ \frac{\text{min}}{\text{DAY}} \times 365\ \frac{\text{day}}{\text{yr}} = 1{,}329{,}800\ \text{GAL/yr}$$

Current HTW Losses :

$$1{,}329{,}800\ \text{GAL/YR} + 20{,}000\ \frac{\text{GAL}}{\text{LEAK}} \times 2\ \frac{\text{LEAKS}}{\text{YR}} = \underline{1{,}369{,}800\ \frac{\text{GAL}}{\text{YR}}}$$

Proposed HTW Losses :

Assume losses in new HTW system will average about 0.10 GPM over the life of the system.

$$0.10\ \text{GPM} \times 1440\ \frac{\text{min}}{\text{day}} \times 365\ \frac{\text{day}}{\text{YR}} = \underline{52{,}560\ \frac{\text{GAL}}{\text{YR}}}$$

ANNUAL SAVINGS

$$\text{Current} = 259320\ \frac{\text{mBtu}}{\text{YR}} + 5210\ \frac{\text{mBtu}}{\text{YR}} = 264{,}530\ \frac{\text{mBtu}}{\text{YR}}\ \text{(Heating)}$$

$$\text{New} = 86440\ \frac{\text{mBtu}}{\text{YR}} + 200\ \frac{\text{mBtu}}{\text{YR}} = 86640\ \text{mBtu/YR}\ \ \text{"}$$

$$\text{HEATING FUELS} = 264530 - 86640 = \boxed{177{,}890\ \text{mBtu/YR}}$$

$$\text{ELECTRICITY} = 6.8 - 0.3 = \boxed{6.5\ \text{mBtu/YR}}$$

$$\text{WATER} = \$762 - \$29 = \boxed{\$733\ /\text{YR}}$$

$$\text{O\&M} = \boxed{\$8124\ /\text{YR}}$$

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | | Reynolds, Smith and Hills, Inc. |
| AEP Number: | 694-1331-002 | | Designer: W. T. Todd |
| Project: | Existing HTW Piping | | Date: 02/08/96 |
| ECO Number: | 1 | | |

Assumptions:

| | | |
|---|---|---|
| 1. HTW temperature | 380 | °F |
| 2. Make-up water temperature | 70 | °F |
| 3. Boiler efficiency | 68% | |
| 4. Pump head (from record drawings) | 300 | Ft H20 |
| 5. Pump efficiency (from record drawings | 72% | |
| 6. Motor efficiency | 90% | |
| 7. Average heating fuel cost | $1.34 | /MBtu |
| 8. Electricity cost | $0.0469 | /kWh |
| 9. Water cost | $0.5562 | /kGallons |

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

1369800 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 3543.6 MBtu/Yr

Heating Fuel Use = 3543.6 MBtu/yr / 0.68 = 5211.2 MBtu/Yr

Heating Fuel Cost = 5211.2 MBtu/yr x $1.34 /MBtu = $6,983 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$\text{BHP} = \frac{2.61 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.27 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency ) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.27 BHP / 0.90 x 0.746 kW/HP = 0.23 kW

Electricity Use = 0.23 kW x 8760 Hr/Yr = 1991 kWh/Yr

Electricity Use = 1991 kWh/Yr x 0.003413 MBtu/kWh = 6.8 MBtu/Yr

Electricity Cost = 1991 kWh/Yr x $0.0469 /kWh = $93 /Year

Water Cost:

1369800 Gal/Yr x $0.5562 /kGal = $762 /Year

Total Utility Cost:

| | | |
|---|---|---|
| Heating Fuel Cost | $6,983 | /Year |
| Pumping (Elec) Cost | $93 | /Year |
| Water Cost | $762 | /Year |
| Total Utility Cost | $7,838 | /Year |

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. | |
| AEP Number: | 694-1331-002 | Designer: | W. T. Todd |
| Project: | Install New Shallow Trench HTW Piping | Date: | 02/08/96 |
| ECO Number: | 1 | | |

Assumptions:

| | | |
|---|---|---|
| 1. HTW temperature | 380 | °F |
| 2. Make-up water temperature | 70 | °F |
| 3. Boiler efficiency | 68% | |
| 4. Pump head (from record drawings) | 300 | Ft H20 |
| 5. Pump efficiency (from record drawings | 72% | |
| 6. Motor efficiency | 90% | |
| 7. Average heating fuel cost | $1.34 | /MBtu |
| 8. Electricity cost | $0.0469 | /kWh |
| 9. Water cost | $0.5562 | /kGallons |

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

52560 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 136.0 MBtu/Yr

Heating Fuel Use = 136.0 MBtu/yr / 0.68 = 200.0 MBtu/Yr

Heating Fuel Cost = 200.0 MBtu/yr x $1.34 /MBtu = $268 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$\text{BHP} = \frac{0.10 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.01 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency ) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.01 BHP / 0.90 x 0.746 kW/HP = 0.01 kW

Electricity Use = 0.01 kW x 8760 Hr/Yr = 76 kWh/Yr

Electricity Use = 76 kWh/Yr x 0.003413 MBtu/kWh = 0.3 MBtu/Yr

Electricity Cost = 76 kWh/Yr x $0.0469 /kWh = $4 /Year

Water Cost:

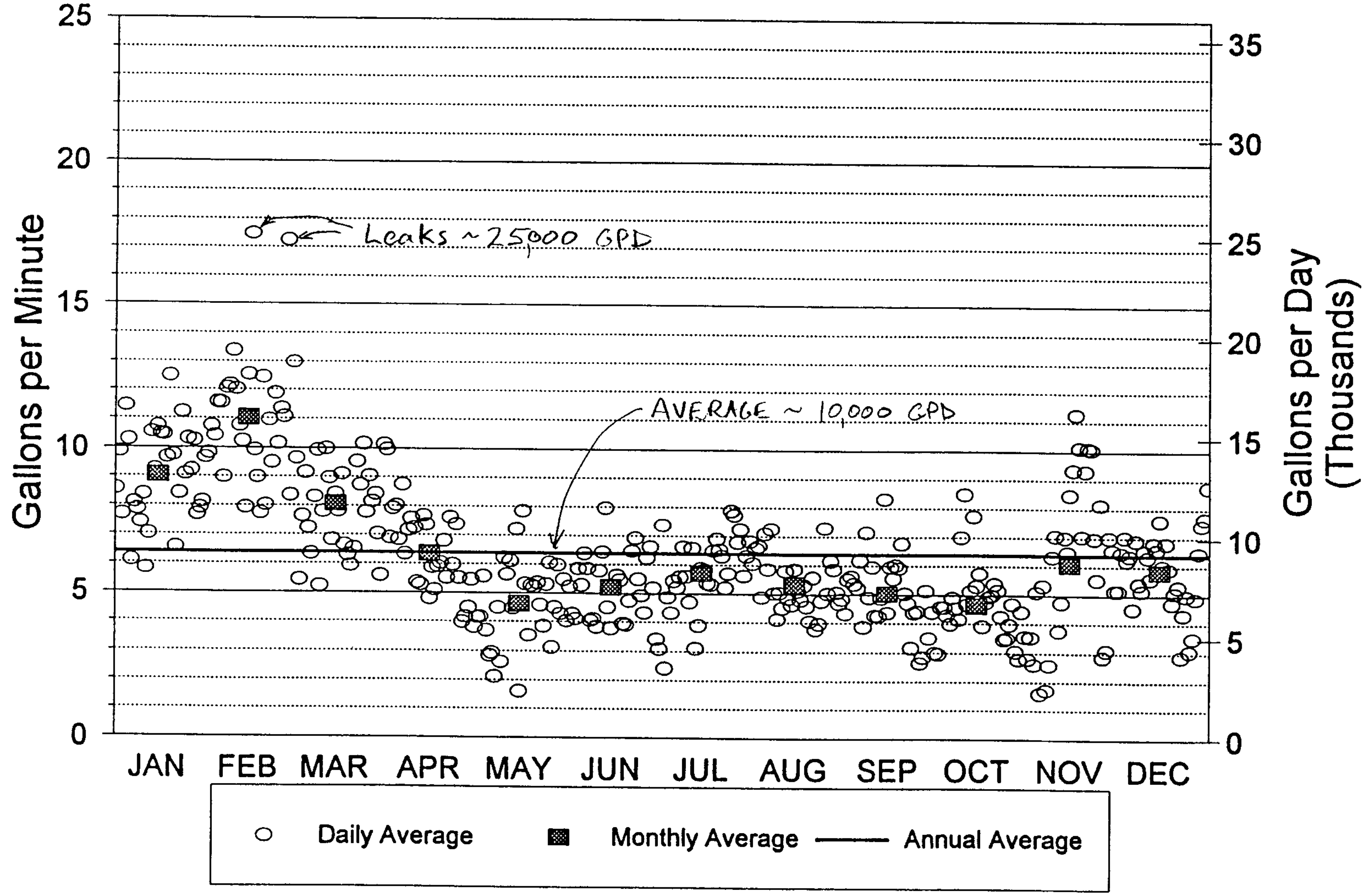
52560 Gal/Yr x $0.5562 /kGal = $29 /Year

Total Utility Cost:

| | | |
|---|---|---|
| Heating Fuel Cost | $268 | /Year |
| Pumping (Elec) Cost | $4 | /Year |
| Water Cost | $29 | /Year |
| Total Utility Cost | $301 | /Year |

Figure #.#

Fort Stewart ~~CEP~~ HTTW Make-up Water, 1995



Fort Stewart – Central Energy Plant
Filename: FS-VPDIS.WQ1
12/15/95

Approximate Distance Between Valve Pits (1)

| | ZONE 1 | | ZONE 2N | | ZONE 2S | | ZONE 3 | | SEP ZONE | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PIT# | LN.FT. | PIT# | LN.FT. | PIT# | LN.FT. | PIT# | LN.FT. | PIT# | LN.FT. | | |
| | CP–B1 | 200 | CP–V1 | 150 | V1–B1 | 700 | CP–? | 700 | C1–V1 | 1500 | (2) | |
| | B1–V4 | 1000 | V1–V2 | 200 | B1–V1 | 1500 | ?–1 | 800 | V1–V2 | 100 | (2) | |
| | V1–V2 | 600 | V2–V3 | 350 | V1–B2 | 300 | ?–2 | 400 | V2–V3 | 1700 | (2) | |
| | V2–V3 | 200 | V3–V4 | 650 | B2–B3 | 550 | 2–2A | 400 | V3–V4 | 450 | (2) | |
| | V3–V4 | 350 | V4–V5 | 600 | B3–V1 | 250 | 2A–3 | 500 | V4–V5 | 600 | (2) | |
| | V4–V5 | 300 | V5–V6 | 800 | V1–V2 | 250 | 3–3A | 400 | V5–V6 | 500 | (2) | |
| | V5–V6 | 550 | V6–V7 | 800 | V1–V3 | 350 | 3A–6 | 550 | V6–SP | 100 | (2) | |
| | V6–V7 | 400 | V2–V8 | 750 | V3–V4 | 250 | 4–5 | 900 | SP–V7 | 200 | | |
| | V7–V8 | 600 | V8–V9 | 300 | V3–V6 | 300 | 5–6 | 650 | V7–V8 | 150 | | |
| | V8–V9 | 350 | | | V4–V5 | 200 | 6–7 | 850 | V8–V9 | 550 | | |
| | V9–V10 | 350 | | | V3–V7 | 650 | 7–8 | 950 | V9–V10 | 650 | | |
| | V10–V11 | 250 | | | V7–V8 | 250 | 8–9 | 1000 | V10–V11 | 800 | | |
| | V11–V12 | 500 | | | V8–V9 | 500 | 9–10 | 1000 | V11–V12 | 650 | | |
| | V12–V13 | 1000 | | | V9–V10 | 200 | 10–11 | 900 | V12–V13 | 800 | | |
| | V13–V14 | 350 | | | V9–V11 | 450 | 11–12 | 500 | | | | |
| | V14–V15 | 400 | | | | | 12–13 | 950 | | | | |
| | V15–V16 | 400 | | | | | 13–13A | 750 | | | | |
| | V16–V17 | 500 | | | | | 12–14 | 950 | | | | |
| | V17–V18 | 800 | | | | | 14–15 | 200 | | | | |
| | | | | | | | 15–16 | 250 | | | | |
| | | | | | | | 16–16A | 300 | | | | |
| | | | | | | | 16A–17 | 200 | | | | |
| | | | | | | | 17–18 | 200 | | | | |
| | | | | | | | 18–19 | 100 | | | | |
| | | | | | | | 19–20 | 150 | | | | |
| | | | | | | | 20–22 | 200 | | | | |
| | | | | | | | 21–22 | 100 | | | | |
| | | | | | | | 22–23 | 350 | | | | |
| | | | | | | | 15–24C | 350 | | | | |
| | | | | | | | 24C–24B | 200 | | | | |
| | | | | | | | 24B–24 | 200 | | | | |
| | | | | | | | 24–24A | 200 | | | | |
| | | | | | | | 24A–25 | 150 | | | | |
| | | | | | | | 24A–25A | 300 | | | | |
| | | | | | | | 25A–26 | 100 | | | | |
| | | | | | | | 26–26A | 200 | | | | |
| | | | | | | | 26A–27 | 250 | | | | |
| | | | | | | | 27–28 | 250 | | | | |
| TOTAL LN.FT. | | 9100 | | 4600 | | 6700 | | 17400 | | 8750 | | |
| MILES | | 1.7 | | 0.9 | | 1.3 | | 3.3 | | 1.7 | | 8.8 |
| MAX LNFT/VP | | 1000 | | 800 | | 1500 | | 1000 | | 1700 | | |
| AVG LNFT/VP | | 479 | | 511 | | 447 | | 458 | | 625 | | |
| MIN LNFT/VP | | 200 | | 150 | | 200 | | 100 | | 100 | | |
| NO. OF PITS (1) | | 19 | | 9 | | 15 | | 38 | | 14 | | 95 |

(1) There are other valve boxes and drain pits that are not shown on our HTW system map.
(2) These pipes carry steam.

CONF-8406132--2

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# ANALYSIS OF A SMALL DISTRICT STEAM SYSTEM AT FT. McCLELLAN, ALABAMA

CONF-8406132
DE84 014051

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For presentation at the
75th Annual Conference of the International
District Heating Association
Mount Washington, New Hampshire

June 17-20, 1984

MASTER



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Of the total steam produced, we estimate that approximately 95% enters the steam distribution system. The remaining 5% is used within the boiler plants to power auxiliaries. This amounts to some 570 lb/hr on the average or 5.0 million lb/yr. Then approximately 96 million lb/yr enters the distribution system.

## 5. CAUSES FOR HEAT LOSS FROM BURIED PIPE

In order to minimize heat losses from steam and condensate pipe lines, the lines are usually insulated. Sometimes the pipes may run above ground but more commonly, the pipes are buried from two to six feet below the surface. If the insulation is intact and dry, the ground helps to insulate the pipe from cold temperatures in the winter and to reduce the heat losses. In this section, we present estimates of the heat losses for well insulated pipes as well as for pipes with deteriorated insulation and under various failure conditions.

Heat Loss From Dry, Insulated, Buried Pipes. Heat losses have been calculated for varied soil conditions and various types of insulation by King et. al. [3]. For the example of a six-inch steam line at 325°F with four inches of calcium silicate insulation in clay of average moisture and a soil temperature of 50°F, the rate of heat loss would be approximately 55 Btu/hour per linear foot of pipe. For the Ft. McClellan system with a steam temperature of 338°F and a ground temperature of 80°F, the loss rate would be about 52 Btu/hr-ft.

Heat Loss From Bare Pipes in Air. The simplest case to consider is a bare pipe exposed to ambient air on a dry, still day. For this case, the two major heat loss mechanisms are natural convection and radiation. We consider the case of a six-inch pipe with 338°F steam and ambient air at 150°F (a typical temperature inside a dry vault, where much of the bare pipe is found). The estimated loss due to natural convection under these conditions is about 350 Btu/hour per foot of pipe. Kreith [4] in Table 5.1 gives a value of emissivity of 0.8 for oxidized steel pipe. For the same pipe, the estimated radiation loss is approximately 570 Btu/hr-ft. The total loss per foot of bare pipe under these circumstances is then 920 Btu/hr-ft.

Buried Pipes With Entrapped Moisture and Deteriorated Insulation. Observations of actual buried steam lines indicates that the heat losses are substantially higher than the theoretical losses. Consideration of the magnitudes of the observed losses suggests that the pipe is behaving as though there were no insulation, and that the pipe is in direct contact with the surrounding soil. The most likely physical explanation is that the conductivity has been greatly enhanced by the deterioration of the insulation from the combined effects of heat and moisture that gets into the system by steam leaks or the intrusion of ground water. Entrapped moisture could be boiling near the surface of the pipe and condensing on the jacket, or subcooled boiling and the formation of a thermal convection loop in water filling the space between the pipe and jacket could be occurring. Both these processes produce extremely high heat transfer rates compared to the rate through dry insulation. If it is assumed that the conductivity of the insulation is infinite, the model of King et al. yields a heat transfer factor of about 1.8 Btu/hr-°F per foot of six-inch diameter pipe. For the six-inch pipe at 330°F and a 80°F ground temperature, the rate of heat loss per foot of pipe would be 460 Btu/hr-ft. This compares with the observed value of about 275 Btu/hr-ft.

Heat Loss From Flooding of Vaults. A commonly observed failure of steam lines is the failure of sump pumps in valve pits and the subsequent covering of the steam pipe with water. The source of the water can be either condensate from steam traps, which collects in the vault and causes flooding when sump pumps fail, or intrusion of ground water into the pits through cracks in the pit wall or around pipes that penetrate the pit walls. Water in the vaults is commonly heated to temperatures that are rather hot; we assume here that the water in the vault is heated to 150°F. The estimated rate of heat loss from a bare, six-inch steam pipe carrying 338°F steam and covered by 150°F water is 50,000 Btu/hr-ft. (This estimate could be higher, perhaps as high as 150,000 Btu/hr-ft depending on the assumed heat transfer mechanism.) Notice that the loss is nearly sixty times as large as the loss from dry, bare pipe. Perhaps even more interesting, the rate of heat loss would be 190 times greater than the

Fort Stewart - Measured/Estimated HTW Leaks
Filename: F-MAKEUP.WQ1

| WATER LOSS ESTIMATE | | |
|---|---|---|
| ITEM | GPD | GPM |
| 1) Blowdown | 1440 | 1.000 |
| 2) Sootblowing | 468 | 0.325 |
| 3) CEP - Misc. Leaks | 298 | 0.207 |
| 4) CEP - No. 4 Boiler | 334 | 0.232 |
| 5) SEP Leaks | 336 | 0.233 |
| 6) Valve Pit Leaks | 1398 | 0.971 |
| 7) Mech. Equip. Room Leaks* | 1260 | 0.875 |
| | | |
| Total Losses Identified | 5534 | 3.843 |
| | | |
| Average 1995 Water Use | 9179 | 6.374 |
| - Total Losses Identified | 5534 | 3.843 |
| | | |
| Estimated HTW Piping Leaks | 3645 | 2.531 |

* Some of the leaks found during the survey of mechanical equipment rooms may have been found and repaired and other leaks might have developed since the surveys were performed.

PIE CHART VALUES

| | | | |
|---|---|---|---|
| Blowdown/Soot Blowing | 1908 | 1.325 | 20.8% |
| CEP/SEP/VP/ME Rm Leaks | 3626 | 2.518 | 39.5% |
| HTW Piping Leaks | 3645 | 2.531 | 39.7% |

BAR CHART VALUES

| | 1993 | 1994 | 1995 |
|---|---|---|---|
| Blowdown/Soot Blowing | 1908 | 1908 | 1908 |
| CEP/SEP/VP/ME Rm Leaks | 3626 | 3626 | 3626 |
| HTW Piping Leaks | 7312 | 8922 | 3645 |

## 022 200 | Excav./Backfill/Compact.

| | | 022 200 Excav./Backfill/Compact. | CREW | DAILY OUTPUT | LABOR-HOURS | UNIT | 1996 BARE COSTS MAT. | LABOR | EQUIP. | TOTAL | TOTAL INCL O&P | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 204 | 0500 | Air tamp, add (A12.3-110) | B-9 | 190 | .211 | C.Y. | | 4.25 | .80 | 5.05 | 7.70 | 204 |
| | 0600 | Vibrating plate, add | A-1 | 60 | .133 | | | 2.64 | 1 | 3.64 | 5.30 | |
| | 0800 | Compaction in 12" layers, hand tamp, add to above | 1 Clab | 34 | .235 | | | 4.66 | | 4.66 | 7.45 | |
| | 0900 | Roller compaction operator walking, add | B-10A | 150 | .080 | | | 1.90 | .57 | 2.47 | 3.58 | |
| | 1000 | Air tamp, add | B-9 | 285 | .140 | | | 2.84 | .53 | 3.37 | 5.10 | |
| | 1100 | Vibrating plate, add | A-1 | 90 | .089 | | | 1.76 | .67 | 2.43 | 3.55 | |
| | 1300 | Dozer backfilling, bulk, up to 300' haul, no compaction | B-10B | 1,200 | .010 | | | .24 | .71 | .95 | 1.15 | |
| | 1400 | Air tamped | B-11B | 240 | .067 | | | 1.52 | 4.46 | 5.98 | 7.30 | |
| | 1600 | Compacting backfill, 6" to 12" lifts, vibrating roller | B-10C | 800 | .015 | | | .36 | 1.19 | 1.55 | 1.86 | |
| | 1700 | Sheepsfoot roller | B-10D | 750 | .016 | | | .38 | 1.29 | 1.67 | 2.01 | |
| | 1900 | Dozer backfilling, trench, up to 300' haul, no compaction | B-10B | 900 | .013 | | | .32 | .95 | 1.27 | 1.53 | |
| | 2000 | Air tamped | B-11B | 235 | .068 | | | 1.55 | 4.56 | 6.11 | 7.40 | |
| | 2200 | Compacting backfill, 6" to 12" lifts, vibrating roller | B-10C | 700 | .017 | | | .41 | 1.37 | 1.78 | 2.13 | |
| | 2300 | Sheepsfoot roller | B-10D | 650 | .018 | | | .44 | 1.49 | 1.93 | 2.32 | |
| 234 | 0010 | **DRILLING AND BLASTING** Only, rock, open face, under 1500 C.Y. | B-47 | 225 | .107 | C.Y. | 1.50 | 2.36 | 2.52 | 6.38 | 8.15 | 234 |
| | 0100 | Over 1500 C.Y. | • | 300 | .080 | | 1.50 | 1.77 | 1.89 | 5.16 | 6.50 | |
| | 2200 | Trenches, up to 1500 C.Y. | B-47 | 22 | 1.091 | | 4.50 | 24 | 25.50 | 54 | 71.50 | |
| | 2300 | Over 1500 C.Y. | • | 26 | .923 | | 4.29 | 20.50 | 22 | 46.79 | 60.50 | |
| 250 | 0010 | **EXCAVATING, STRUCTURAL** Hand, pits to 6' deep, sandy soil | 1 Clab | 8 | 1 | C.Y. | | 19.80 | | 19.80 | 31.50 | 250 |
| | 0100 | Heavy soil or clay | | 4 | 2 | | | 39.50 | | 39.50 | 63 | |
| | 0300 | Pits 6' to 12' deep, sandy soil | | 5 | 1.600 | | | 31.50 | | 31.50 | 50.50 | |
| | 0500 | Heavy soil or clay | | 3 | 2.667 | | | 53 | | 53 | 84.50 | |
| | 0700 | Pits 12' to 18' deep, sandy soil | | 4 | 2 | | | 39.50 | | 39.50 | 63 | |
| | 0900 | Heavy soil or clay | | 2 | 4 | | | 79 | | 79 | 126 | |
| | 1500 | For wet or muck hand excavation, add to above | | | | % | | | | 50% | 50% | |
| 254 | 0010 | **EXCAVATING, TRENCH** or continuous footing, common earth (A12.3-110) | | | | | | | | | | 254 |
| | 0020 | No sheeting or dewatering included | | | | | | | | | | |
| | 0050 | 1' to 4' deep, 3/8 C.Y. tractor loader/backhoe | B-11C | 150 | .107 | C.Y. | | 2.43 | 1.39 | 3.82 | 5.30 | |
| | 0060 | 1/2 C.Y. tractor loader/backhoe | B-11M | 200 | .080 | | | 1.82 | 1.43 | 3.25 | 4.41 | |
| | 0090 | 4' to 6' deep, 1/2 C.Y. tractor loader/backhoe | • | 200 | .080 | | | 1.82 | 1.43 | 3.25 | 4.41 | |
| | 0100 | 5/8 C.Y. hydraulic backhoe | B-12Q | 250 | .064 | | | 1.56 | 1.58 | 3.14 | 4.12 | |
| | 0110 | 3/4 C.Y. hydraulic backhoe | B-12F | 300 | .053 | | | 1.30 | 1.50 | 2.80 | 3.64 | |
| | 0300 | 1/2 C.Y. hydraulic excavator, truck mounted | B-12J | 200 | .080 | | | 1.95 | 3.15 | 5.10 | 6.45 | |
| | 0500 | 6' to 10' deep, 3/4 C.Y. hydraulic backhoe | B-12F | 225 | .071 | | | 1.73 | 2 | 3.73 | 4.86 | |
| | 0600 | 1 C.Y. hydraulic excavator, truck mounted | B-12K | 400 | .040 | | | .97 | 2.17 | 3.14 | 3.88 | |
| | 0900 | 10' to 14' deep, 3/4 C.Y. hydraulic backhoe | B-12F | 200 | .080 | | | 1.95 | 2.25 | 4.20 | 5.45 | |
| | 1000 | 1-1/2 C.Y. hydraulic backhoe | B-12B | 540 | .030 | | | .72 | 1.32 | 2.04 | 2.56 | |
| | 1300 | 14' to 20' deep, 1 C.Y. hydraulic backhoe | B-12A | 320 | .050 | | | 1.22 | 1.72 | 2.94 | 3.77 | |
| | 1400 | By hand with pick and shovel to 6' deep, light soil | 1 Clab | 8 | 1 | | | 19.80 | | 19.80 | 31.50 | |
| | 1500 | Heavy soil | • | 4 | 2 | | | 39.50 | | 39.50 | 63 | |
| | 1700 | For tamping backfilled trenches, air tamp, add | A-1 | 100 | .080 | | | 1.58 | .60 | 2.18 | 3.19 | |
| | 1900 | Vibrating plate, add | | 90 | .089 | | | 1.76 | .67 | 2.43 | 3.55 | |
| | 2100 | Trim sides and bottom for concrete pours, common earth | | 600 | .013 | S.F. | | .26 | .10 | .36 | .53 | |
| | 2300 | Hardpan | | 180 | .044 | • | | .88 | .33 | 1.21 | 1.77 | |
| 258 | 0010 | **EXCAVATING, UTILITY TRENCH** Common earth | | | | | | | | | | 258 |
| | 0050 | Trenching with chain trencher, 12 H.P., operator walking | | | | | | | | | | |
| | 0100 | 4" wide trench, 12" deep | B-53 | 800 | .010 | L.F. | | .25 | .11 | .36 | .50 | |
| | 0150 | 18" deep | | 750 | .011 | | | .26 | .11 | .37 | .52 | |
| | 0200 | 24" deep | | 700 | .011 | | | .28 | .12 | .40 | .56 | |
| | 0300 | 6" wide trench, 12" deep | | 650 | .012 | | | .30 | .13 | .43 | .61 | |
| | 0350 | 18" deep | | 600 | .013 | | | .33 | .14 | .47 | .66 | |
| | 0400 | 24" deep | | 550 | .015 | | | .36 | .15 | .51 | .72 | |
| | 0450 | 36" deep | | 450 | .018 | | | .44 | .19 | .63 | .88 | |
| | 0600 | 8" wide trench, 12" deep | | 475 | .017 | | | .42 | .18 | .60 | .84 | |

A.3.1-15

# CONSTRUCTION COST ESTIMATE

| | | | |
|---|---|---|---|
| Project: | Shallow Trench HTW Piping System | RS&H No.: | 694-1331-002 |
| Location: | Fort Stewart, GA | Date: | 14-Feb-96 |
| Basis: | Schematic Design | Estimator: | W.T.Todd |
| ECO No.: | 1 | Filename: | EST-1.WB2 |

| ITEM DESCRIPTION | QUANTITY | | MATERIAL/EQUIP | | LABOR | | TOTAL COST | SOURCE | |
|---|---|---|---|---|---|---|---|---|---|
| | No. | Unit | $/Unit | Total | $/Unit | Total | | Material | Labor |
| Excavating Trench | 60900 | CY | 1.37 | 83433 | 1.73 | 105357 | 188,790 | MMp23 | MMp23 |
| Piping Demolition, to 2" | 40887 | LF | NA | 0 | 1.13 | 46202 | 46,202 | MMp17 | MMp17 |
| Piping Demolition, to 4" | 22880 | LF | NA | 0 | 1.51 | 34549 | 34,549 | MMp17 | MMp17 |
| Piping Demolition, to 8" | 34430 | LF | NA | 0 | 4.53 | 155968 | 155,968 | MMp17 | MMp17 |
| Piping Demolition, to 16" | 23540 | LF | NA | 0 | 7.55 | 177727 | 177,727 | MMp17 | MMp17 |
| Scrap Salvage, Steel | 1593 | Ton | -60.00 | -95570 | NA | 0 | (95,570) | MMp17 | MMp17 |
| HTW Pipe, 2" Sch 80 Steel | 40887 | LF | 5.17 | 211529 | 6.51 | 266031 | 477,560 | MMp107 | MMp107 |
| Joint Weld, 2" Sch 80 | 4089 | Ea | 3.41 | 13942 | 27.00 | 110395 | 124,337 | MMp109 | MMp109 |
| Insul., 2" Wall, 2" Pipe | 40887 | LF | 3.37 | 137789 | 3.10 | 126750 | 264,539 | MMp199 | MMp199 |
| HTW Pipe, 4" Sch 80 Steel | 22880 | LF | 14.31 | 327413 | 11.61 | 265614 | 593,027 | MMp107 | MMp107 |
| Joint Weld, 4" Sch 80 | 2288 | Ea | 4.65 | 10639 | 37.00 | 84656 | 95,295 | MMp109 | MMp109 |
| Insul., 2" Wall, 4" Pipe | 22880 | LF | 4.56 | 104333 | 3.37 | 77106 | 181,439 | MMp199 | MMp199 |
| HTW Pipe, 6" Sch 80 Steel | 24970 | LF | 30.95 | 772822 | 20.16 | 503395 | 1,276,217 | MMp107 | MMp107 |
| Joint Weld, 6" Sch 80 | 2497 | Ea | 10.25 | 25594 | 81.50 | 203506 | 229,100 | MMp109 | MMp109 |
| Insul., 2" Wall, 6" Pipe | 24970 | LF | 5.85 | 146075 | 3.69 | 92139 | 238,214 | MMp199 | MMp199 |
| HTW Pipe, 8" Sch 80 Steel | 9460 | LF | 52.44 | 496082 | 24.48 | 231581 | 727,663 | MMp107 | MMp107 |
| Joint Weld, 8" Sch 80 | 946 | Ea | 12.80 | 12109 | 102 | 96492 | 108,601 | MMp109 | MMp109 |
| Insul., 2" Wall, 8" Pipe | 9460 | LF | 6.95 | 65747 | 4.08 | 38597 | 104,344 | MMp199 | MMp199 |
| HTW Pipe, 10" Sch 80 Stl | 23540 | LF | 70.06 | 1649212 | 30.24 | 711850 | 2,361,062 | MMp107 | MMp107 |
| Joint Weld, 10" Sch 80 | 2354 | Ea | 17.05 | 40136 | 136 | 320144 | 360,280 | MMp109 | MMp109 |
| Insul., 2" Wall, 10" Pipe | 23540 | LF | 8.65 | 203621 | 4.56 | 107342 | 310,963 | MMp199 | MMp199 |
| Conduit, 20" Sch 40 Steel | 33000 | LF | 75.05 | 2476650 | 62.04 | 2047320 | 4,523,970 | MMp104 | MMp104 |
| Joint Weld, 20" Sch 40 | 3300 | Ea | 28.50 | 94050 | 226 | 745800 | 839,850 | MMp109 | MMp109 |
| Conduit, 16" Sch 40 Steel | 36410 | LF | 56.18 | 2045514 | 43.12 | 1569999 | 3,615,513 | MMp104 | MMp104 |
| Joint Weld, 16" Sch 40 | 3641 | Ea | 23.50 | 85564 | 185 | 673585 | 759,149 | MMp109 | MMp109 |
| Conduit, 14" Sch 40 Steel | 20444 | LF | 48.06 | 982515 | 37.40 | 764587 | 1,747,102 | MMp104 | MMp104 |
| Joint Weld, 14" Sch 40 | 2044 | Ea | 19.70 | 40274 | 157 | 320963 | 361,237 | MMp109 | MMp109 |
| Valves, Fittings, etc. | All | -- | 10% | 421704 | 10% | 323560 | 745,264 | Estimate | Estimate |
| Dozer Backfill, Trench | 60900 | CY | 0.91 | 55419 | 0.30 | 18270 | 73,689 | MMp23 | MMp23 |
| Compacting Backfill | 60900 | CY | 1.31 | 79779 | 0.39 | 23751 | 103,530 | MMp23 | MMp23 |
| Subtotal Bare Costs | | | | 10486375 | | 10243236 | $20,729,611 | | |
| Retrofit Cost Factors | | | 4.0% | 419455 | 7.0% | 717027 | 1,136,482 | MMp4 | MMp4 |
| Subtotal | | | | 10905830 | | 10960263 | 21,866,093 | | |
| City Cost Index (Sav. GA) | | | -2.4% | -261740 | -40.4% | -4427946 | (4,689,686) | MEp439 | MEp439 |
| Subtotal | | | | 10644090 | | 6532317 | 17,176,407 | | |
| OH & Profit Markups | | | 10.0% | 1064409 | 50.0% | 3266159 | 4,330,568 | MEp5 | MEpIBC |
| Subtotal | | | | 11708499 | | 9798476 | 21,506,975 | | |
| Sales Taxes | | | 4.0% | 468340 | | NA | 468,340 | | |
| Total Construction Cost | | | | 12176839 | | 9798476 | 21,975,315 | | |
| Design Fee | | | | NA | 6.0% | 1318519 | 1,318,519 | | |
| SIOH | | | | NA | 6.0% | 1318519 | 1,318,519 | | |
| Subtotal | | | | 12176839 | | 12435514 | 24,612,353 | | |
| Contingency | | | 0.0% | 0 | 0.0% | 0 | 0 | MEp4 | MEp4 |
| Total Project Cost | | | | 12176839 | | 12435514 | $24,612,353 | | |

LEGEND:

MMp### 1995 Means Mechanical Cost Data, page ###.

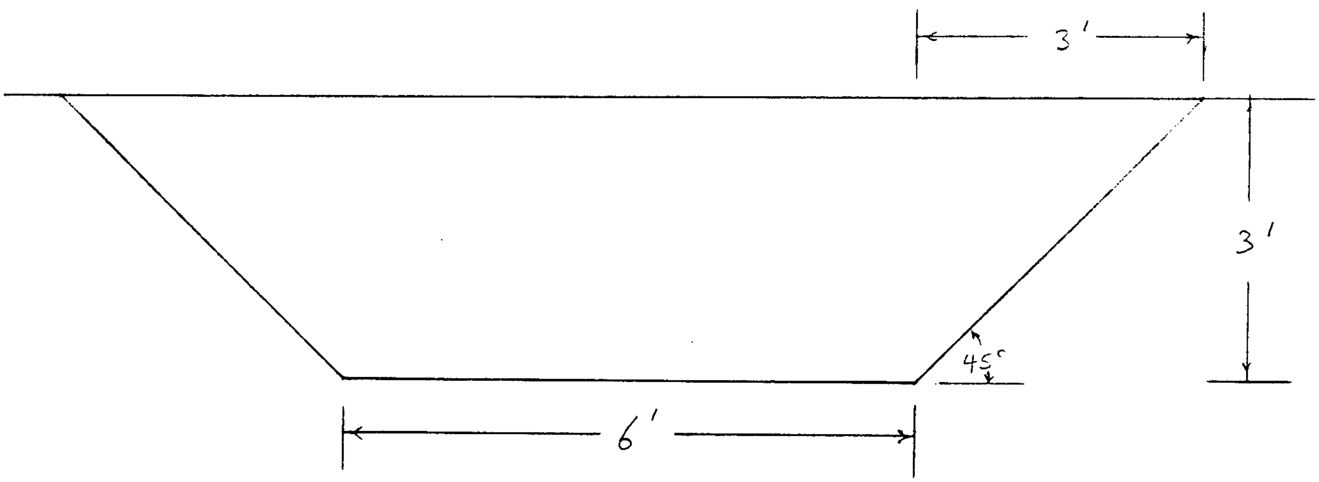
RS&H

SUBJECT FORT STEWART
REPLACE HTW PIPING
DESIGNER W. Todd
CHECKER

AEP NO 694 1331 002
SHEET ____ OF ____
DATE 2-7-96
DATE

## Shallow Trench Piping System

Excavation & Backfill :




Cubic yards (CY) per linear foot

$1' \times 3' \times 9' = 27 \text{ ft}^3$

$27 \text{ ft}^3 \div 27 \text{ cf/cy} = 1 \text{ CY / lf}$

HTW pipe lengths and sizes were taken off of the Central Heating and Cooling drawings. A list of the pipe sizes and lengths used for cost estimating is contain on the following pages.

Fort Stewart
Estimate of HTW System Pipe Lengths
Filename: F-PIPING.WQ1

| Pipe Service | Bldg. Served | Pipe Dia. (in) | Linear Ft w/loops | |
|---|---|---|---|---|
| HTWS | All (main) | 10 | 3850 | |
| HTWR | All (main) | 10 | 3850 | |
| HTWR | All (main) | 10 | 5225 | |
| STMS | All (main) | 10 | 5390 | |
| HTWS | All (main) | 10 | 5225 | |
| Subtotal | | | 23540 | LnFt |
| HTWR | All (main) | 8 | 440 | |
| HTWS | All (main) | 8 | 440 | |
| HTWS | All (main) | 8 | 605 | |
| HTWS | All (main) | 8 | 1485 | |
| HTWR | All (main) | 8 | 605 | |
| HTWR | All (main) | 8 | 2200 | |
| HTWS | All (main) | 8 | 2200 | |
| HTWR | All (main) | 8 | 1485 | |
| Subtotal | | | 9460 | LnFt |
| HTWR | All (main) | 6 | 4070 | |
| HTWS | All (main) | 6 | 4070 | |
| HTWS | All (main) | 6 | 1980 | |
| HTWR | All (main) | 6 | 1980 | |
| HTWS | All (main) | 6 | 605 | |
| HTWR | All (main) | 6 | 605 | |
| HTWR | All (main) | 6 | 2035 | |
| HTWS | All (main) | 6 | 825 | |
| HTWR | All (main) | 6 | 825 | |
| HTWS | All (main) | 6 | 220 | |
| HTWR | All (main) | 6 | 220 | |
| HTWS | All (main) | 6 | 2035 | |
| HTWS | All (main) | 5 | 385 | |
| HTWS | All (main) | 5 | 990 | |
| HTWR | All (main) | 5 | 990 | |
| HTWR | All (main) | 5 | 385 | |
| HTWR | All (main) | 5 | 1375 | |
| HTWS | All (main) | 5 | 1375 | |
| Subtotal | | | 24970 | LnFt |
| HTWR | All (main) | 4 | 2860 | |
| HTWS | All (main) | 4 | 825 | |
| HTWR | All (main) | 4 | 825 | |
| HTWS | All (main) | 4 | 2860 | |
| HTWS | All (main) | 4 | 880 | |
| HTWS | All (main) | 4 | 550 | |
| HTWR | All (main) | 4 | 880 | |

Fort Stewart
Estimate of HTW System Pipe Lengths
Filename: F-PIPING.WQ1

| Pipe Service | Bldg. Served | Pipe Dia. (in) | Linear Ft w/loops | |
|---|---|---|---|---|
| HTWS | All (main) | 4 | 1650 | |
| HTWR | All (main) | 4 | 1100 | |
| HTWR | All (main) | 4 | 550 | |
| HTWR | All (main) | 4 | 1650 | |
| HTWR | All (main) | 4 | 5390 | |
| HTWS | All (main) | 4 | 1100 | |
| HTWS | All (main) | 3 | 880 | |
| HTWR | All (main) | 3 | 880 | |
| Subtotal | | | 22880 | LnFt |
| HTWR | All (main) | 2.5 | 1760 | |
| HTWS | All (main) | 2.5 | 1760 | |
| HTWS | All (main) | 2.5 | 440 | |
| HTWR | All (main) | 2.5 | 440 | |
| HTWR | All (main) | 2.5 | 550 | |
| HTWS | All (main) | 2.5 | 550 | |
| HTWS | All (main) | 2.25 | 990 | |
| HTWR | All (main) | 2.25 | 990 | |
| HTWR | All (main) | 2 | 990 | |
| HTWS | All (main) | 2 | 990 | |
| HTWS | All (main) | 2 | 770 | |
| HTWR | All (main) | 2 | 770 | |
| HTWR | All (main) | 2 | 5390 | |
| HTWS | All (main) | 2 | 770 | |
| HTWR | All (main) | 2 | 770 | |
| HTWR | All (main) | 2 | 4510 | |
| HTWS | All (main) | 2 | 4510 | |
| HTWR | All (main) | 2 | 880 | |
| HTWS | All (main) | 2 | 880 | |
| HTWR | All (main) | 2 | 880 | |
| HTWS | All (main) | 2 | 880 | |
| HTWS | All (main) | 1.5 | 330 | |
| HTWR | All (main) | 1.5 | 330 | |
| HTWR | All (main) | 1.25 | 1980 | |
| HTWS | All (main) | 1.25 | 1980 | |
| Branch Piping (5% of mains) | | | 1689 | |
| Branch Piping (5% of mains) | | | 1579 | |
| Branch Piping (5% of mains) | | | 1018 | |
| Branch Piping (5% of mains) | | | 1513 | |
| Subtotal | | | 40887 | LnFt |
| | | | | |
| Total | | | 121737 | LnFt |

# ECO NUMBER 2

## REDUCE BLOWDOWN OF THE CASCADE HEATERS AND THE WOOD-FIRED BOILER

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-2
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-2 REDUCE BLOWDOWN FREQUENCY
FISCAL YEAR 1995 DISCRETE PORTION NAME: REDUCE BLOWDOWN BY 50%
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 500. | | |
| B. SIOH | $ 0. | | |
| C. DESIGN COST | $ 0. | | |
| D. TOTAL COST (1A+1B+1C) | $ 500. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 500. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 0. | 15.08 | $ 0. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 1000. | $ 1340. | 14.88 | $ 19939. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 1000. | $ 1340. | | $ 19939. |

3. NON ENERGY SAVINGS(+) / COST(-)

| | | |
|---|---|---|
| A. ANNUAL RECURRING (+/-) | | $ 2505. |
| (1) DISCOUNT FACTOR (TABLE A) | 14.88 | |
| (2) DISCOUNTED SAVING/COST (3A X 3A1) | | $ 37274. |

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 37274.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 3845.

5. SIMPLE PAYBACK PERIOD (1G/4) .13 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 57214.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 114.43
(IF < 1 PROJECT DOES NOT QUALIFY)

WITH ECO'S 9A & 12A

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: ECO-2X
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)

INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-2 REDUCE BLOWDOWN FREQUENCY
FISCAL YEAR 1995 DISCRETE PORTION NAME: REDUCE BLOWDOWN BY 50%
ANALYSIS DATE: 02-15-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | |
|---|---|---|
| A. CONSTRUCTION COST | $ | 500. |
| B. SIOH | $ | 0. |
| C. DESIGN COST | $ | 0. |
| D. TOTAL COST (1A+1B+1C) | $ | 500. |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | $ | 0. |
| F. PUBLIC UTILITY COMPANY REBATE | $ | 0. |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | $ | 500. |

2. ENERGY SAVINGS (+) / COST (-)

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 0. | 15.08 | $ 0. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 864. | $ 1158. | 14.88 | $ 17227. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 864. | $ 1158. | | $ 17227. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 2505.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 37274.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 37274.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 3663.

5. SIMPLE PAYBACK PERIOD (1G/4) .14 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 54502.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 109.00
(IF < 1 PROJECT DOES NOT QUALIFY)

WITH ECO'S 9A, 12A & 12B

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-2Y
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-2 REDUCE BLOWDOWN FREQUENCY
FISCAL YEAR 1995 DISCRETE PORTION NAME: REDUCE BLOWDOWN BY 50%
ANALYSIS DATE: 02-15-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT
A. CONSTRUCTION COST $ 500.
B. SIOH $ 0.
C. DESIGN COST $ 0.
D. TOTAL COST (1A+1B+1C) $ 500.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 500.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 0. | 15.08 | $ 0. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 765. | $ 1025. | 14.88 | $ 15253. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 765. | $ 1025. | | $ 15253. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 2505.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 37274.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 37274.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 3530.

5. SIMPLE PAYBACK PERIOD (1G/4) .14 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 52528.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 105.06
(IF < 1 PROJECT DOES NOT QUALIFY)

**RS&H**

| | | | |
|---|---|---|---|
| SUBJECT | Fort Stewart | AEP NO | 694 1331 002 |
| | Reduce Blowdown | SHEET | OF |
| DESIGNER | G. Fallon | DATE | 2-7-96 |
| CHECKER | | DATE | |

ECO No. 2 REDUCE BLOWDOWN FREQUENCY

BOILER WATER TESTS SHOW WATER IS CLEANER THAN SHOULD BE IMPLYING BLOWDOWN FREQUENCY IS TOO HIGH FOR SOLIDS BEING GENERATED.
INITIALLY, BLOWDOWN FREQUENCY SHOULD BE REDUCED, PERHAPS TO ODD NUMBERED DAYS AND THE DURATION OF BLOWDOWN SHOULD NOT BE CHANGED.

CURRENT HTW USE (see table for calculation)

$$1440 \frac{\text{GAL}}{\text{Day}} \times 365 \text{ days/yr} = \underline{525600 \text{ GAL/YR}}$$

ANNUAL COST for O&M

$$30 \text{ min/day} \times 365 \text{ day/YR} \times \$25.86/\text{hr} = \underline{\$4720/\text{YR}}$$

HTW SAVINGS

CURRENT BOILER WATER CONCENTRATIONS ARE ABOUT 1/2 THE RECOMMENDED VALUE, THEREFORE BLOWDOWN CAN BE CUT IN HALF.

$$525600 \text{ GAL/YR} \times 0.50 = \underline{262800 \text{ GAL/YR}}$$

O&M Cost Savings

$$\$4720/\text{YR} \times 0.5 = \boxed{\$2360/\text{YR}}$$

CAPITAL EXPENSE IS REQUIRED TO OBTAIN THIS SAVINGS.

Additional water analysis: 5 tests and reports × \$100 ea = $\underline{\$500}$

| | |
|---|---|
| Location: | Fort Stewart, GA |
| AEP Number: | 694-1331-002 |
| Project: | Existing Blowdown |
| ECO Number: | 2 |

Reynolds, Smith and Hills, Inc.
Designer: W. T. Todd
Date: 02/08/96

Assumptions:

| | | |
|---|---|---|
| 1. HTW temperature | 380 | °F |
| 2. Make-up water temperature | 70 | °F |
| 3. Boiler efficiency | 68% | |
| 4. Average heating fuel cost | $1.34 | /MBtu |
| 5. Water cost | $0.5562 | /kGallons |

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

525600 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 1359.7 MBtu/Yr

Heating Fuel Use = 1359.7 MBtu/yr / 0.68 = 1999.6 MBtu/Yr

Heating Fuel Cost = 1999.6 MBtu/yr x $1.34 /MBtu = $2,679 /Year

Water Cost:

525600 Gal/Yr x $0.5562 /kGal = $292 /Year

Total Utility Cost:

| | | |
|---|---|---|
| Heating Fuel Cost | $2,679 | /Year |
| Water Cost | $292 | /Year |
| Total Utility Cost | $2,971 | /Year |

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. | |
| AEP Number: | 694-1331-002 | Designer: | W. T. Todd |
| Project: | Reduce Blowdown | Date: | 02/08/96 |
| ECO Number: | 2 | | |

Assumptions:

1. HTW temperature — 380 °F
2. Make-up water temperature — 70 °F
3. Boiler efficiency — 68%
4. Average heating fuel cost — $1.34 /MBtu
5. Water cost — $0.5562 /kGallons

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

262800 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 679.9 MBtu/Yr

Heating Fuel Use = 679.9 MBtu/yr / 0.68 = 999.8 MBtu/Yr

Heating Fuel Cost = 999.8 MBtu/yr x $1.34 /MBtu = $1,340 /Year

Water Cost:

262800 Gal/Yr x $0.5562 /kGal = $146 /Year

Total Utility Cost:

| | | |
|---|---|---|
| Heating Fuel Cost | $1,340 | /Year |
| Water Cost | $146 | /Year |
| Total Utility Cost | $1,486 | /Year |

ANNUAL SAVINGS

HEATING FUELS = 2000 - 1000 = $\boxed{\text{1000 MBtu/YR}}$

WATER COST = $292 - $146 = $\boxed{\text{\$146/YR}}$

## Estimated Water Consumption Due to Blowdown

| Blowdown Point | Duration Est. (min) | | Pipe Dia. | Pipe Length | Pres. Drop | Flow | | | Average |
|---|---|---|---|---|---|---|---|---|---|
| | Est. #1 | Est. #2 | (in) | (ft) | (ft) | (gpm) | (gpd, #1) | (gpd, #2) | (gpd) |
| **Intermittent (1)** | | | | | | | | | |
| Heater #1 | 0.42 | 0.17 | 1 | 100 | 400 | 87.5 | 36.5 | 14.6 | |
| Level Xmtr. | 0.20 | 0.08 | 1 | 10 | 400 | 320.9 | 64.2 | 26.7 | |
| Heater #2 | 0.42 | 0.17 | 1 | 100 | 400 | 87.5 | 36.5 | 14.6 | |
| Level Xmtr. | 0.20 | 0.08 | 1 | 10 | 400 | 320.9 | 64.2 | 26.7 | |
| Heater #3 | 0.42 | 0.17 | 1 | 100 | 400 | 87.5 | 36.5 | 14.6 | |
| Level Xmtr. | 0.20 | 0.08 | 1 | 10 | 400 | 320.9 | 64.2 | 26.7 | |
| No. 4 Boiler | | | | | | | | | |
| East Wall | 0.33 | 0.50 | 1 | 100 | 400 | 87.5 | 29.2 | 43.8 | |
| West Wall | 0.33 | 0.50 | 1 | 100 | 400 | 87.5 | 29.2 | 43.8 | |
| Rear Wall | 0.33 | 0.50 | 1 | 100 | 400 | 87.5 | 29.2 | 43.8 | |
| East Drum | 0.33 | 0.50 | 1 | 100 | 400 | 87.5 | 29.2 | 43.8 | |
| West Drum | 0.33 | 0.50 | 1 | 100 | 400 | 87.5 | 29.2 | 43.8 | |
| **Sub-total Intermittent Blowdown - Summer** | | | | | | | 448 | 343 | 395 |
| Heater #4 | 0.42 | 0.17 | 1 | 100 | 400 | 87.5 | 36.5 | 14.6 | |
| Level Xmtr. | 0.20 | 0.08 | 1 | 10 | 400 | 320.9 | 64.2 | 26.7 | |
| Heater #5 | 0.42 | 0.17 | 1 | 100 | 400 | 87.5 | 36.5 | 14.6 | |
| Level Xmtr. | 0.20 | 0.08 | 1 | 10 | 400 | 320.9 | 64.2 | 26.7 | |
| **Additional Intermittent Blowdown - Winter** | | | | | | | 201 | 83 | 142 |
| **Continuous (2)** | | | | | | | | | |
| Steam Drum | 1440 | 0 | 1/16 | 100 | 400 | 1.353 | 1948 | 0 | 974 |
| **Total Blowdown - Summer** | | | | | | | 2396 | 343 | 1369 |
| **Total Blowdown - Winter** | | | | | | | 2597 | 425 | 1511 |

(1) Assumes 200 psi, 1 inch orifice, square edged, C=0.82; Cameron Hydraulic Data, pages 2-8 and 2-9.
(2) Assumes 200 psi, 1/16 inch orifice, square edged, C=0.82; Cameron Hydraulic Data, pages 2-8 and 2-9.

# CONSTRUCTION COST ESTIMATE

| | | | |
|---|---|---|---|
| Project: | Reduce Blow Down | RS&H No.: | 694-1331-002 |
| Location: | Fort Stewart, GA | Date: | 05/24/96 |
| Basis: | Schematic Design | Estimator: | W.T.Todd |
| ECO No.: | 2 | Filename: | EST-2.WB2 |

| ITEM DESCRIPTION | QUANTITY | | MATERIAL/EQUIP | | LABOR | | TOTAL COST | SOURCE | |
|---|---|---|---|---|---|---|---|---|---|
| | No. | Unit | $/Unit | Total | $/Unit | Total | | Material | Labor |
| Boiler Water Analysis | 5 | Ea | 0 | 0 | 100 | 500 | 500 | | Est. |
| Subtotal Bare Costs | | | | 0 | | 500 | $500 | | |
| Retrofit Cost Factors | | | 0% | 0 | 0% | 0 | 0 | MMp6 | MMp6 |
| Subtotal | | | | 0 | | 500 | 500 | | |
| City Cost Index (Sav. GA) | | | 0% | 0 | 0% | 0 | 0 | MMp533 | MMp533 |
| Subtotal | | | | 0 | | 500 | 500 | | |
| OH & Profit Markups | | | 0% | 0 | 0% | 0 | 0 | MMp7 | MMp475 |
| Subtotal | | | | 0 | | 500 | 500 | | |
| Sales Taxes | | | 4.0% | 0 | | NA | 0 | MMp476 | |
| Total Construction Cost | | | | 0 | | 500 | 500 | | |
| Design Fee | | | | NA | 0.0% | 0 | 0 | | |
| SIOH | | | | NA | 0.0% | 0 | 0 | | |
| Subtotal | | | | 0 | | 500 | 500 | | |
| Contingency | | | 0% | 0 | 0% | 0 | 0 | MEp6 | MEp6 |
| Total Project Cost | | | | 0 | | 500 | $500 | | |

LEGEND:
MMp### 1996 Means Mechanical Cost Data, page ###.

# BOILER SYSTEM WATER ANALYSIS PROGRAM

## FORT STEWART BUILDING 1412 BOILER 4

Sample Number . . . . XCSTEWBW
Date Sampled . . . . . 07/18/95
Date Received . . . . 08/14/95
Date Analyzed . . . . 08/17/95
Date Report Issued . 08/25/95

### Boiler Water Analysis Report

| Test Description | P&A | Plant | Control |
|---|---|---|---|
| Specific Sx Description | | | |
| Total Hardness, ppm $CaCO_3$ | <2 | | |
| Filt Ortho Phos, ppm $PO_4$ | 23 | 35 | 30 - 60 |
| Polymer, ppm | | | N/A |
| Sulfite, ppm $Na_2SO_3$ | 549 | 800 | 20 - 40 |
| P Alkalinity, ppm $CaCO_3$ | 360 | | |
| Causticity, ppm $OH^-$ | 120 | 115 | 20 - 200 |
| pH | 11.8 | 11.8 | |
| Neut Conductivity, mmhos | 2000 | 2200 | |
| Total Diss Solids, ppm | 1400 | 1540 | 3000 - 3500 |

Specific Installation Information

Post.................................... Fort Stewart
City/State/Zip............ Fort Stewart. GA 31314-5000
Phone.................................. (912) 767-8931

Building Sample is From........... Central Energy Plant
Description of Sample................. BW From Boiler 4

Pretreatment.................................... Resin

Feedwater Temp (F)...................................... 212
Feedwater Deoxygenation Method(s):
Mechanical.......................................
Oxygen Scavenger.................... Sodium Sulfite

Boiler Type................................. Water Tube
Steam Gauge Pressure (PSIG)........................ 220
Boiler Horsepower.......................................
Boiler Output (PPH)........................... 99,000
Boiler Treatment:
pH Control.......................................
Phosphate.................sodium hexametaphosphate
Dispersant.......................................

Condensate pH Control........................morpholine

Comments

NOTE: REMARKS AND RECOMMENDATIONS REFLECT CONDITIONS AT TIME OF SAMPLING AND MAY NOT APPLY TO CURRENT CONDITIONS.

REMARKS:

1. Test agreement is good overall noting only a minor discrepancy for phosphate . Sulfite difference is normal since sulfite will degrade over time.

2. Results show that phosphate is below the control range. Sulfite is signficantly overdosed while causticity is within range. Blowdown is excessive based on low TDS.

continued...

Puckorius & Associates, Inc. P.O. Box 2440, Evergreen, CO 80439 303-674-9897

# BOILER SYSTEM WATER ANALYSIS PROGRAM

## FORT STEWART BUILDING 1412 BOILER 4

Sample Number . . . . RPSTEWBW
Date Sampled . . . . 06/06/95
Date Received . . . . 06/16/95
Date Analyzed . . . . 06/27/95
Date Report Issued . 07/06/95

### Boiler Water Analysis Report

| Test Description | P&A | Plant | Control |
|---|---|---|---|
| Specific Sx Description | | | |
| Total Hardness, ppm $CaCO_3$ | <2 | | |
| Filt Ortho Phos, ppm $PO_4$ | 44 | 40 | 30 - 60 |
| Tannin Color | | | |
| Polymer, ppm | | | N/A |
| Sulfite, ppm $Na_2SO_3$ | 650 | 780 | 20 - 40 |
| P Alkalinity, ppm $CaCO_3$ | 410 | | |
| M Alkalinity, ppm $CaCO_3$ | | | |
| Causticity, ppm $OH^-$ | 130 | 115 | 20 - 200 |
| pH | 11.7 | 11.7 | |
| Neut Conductivity, mmhos | 2480 | 2300 | |
| Total Diss Solids, ppm | 1750 | 1610 | 3000 - 3500 |

### Specific Installation Information

Post.................................... Fort Stewart
City/State/Zip............ Fort Stewart, GA 31314-5000
Phone.................................. (912) 767-8931

Building Sample is From........... Central Energy Plant
Description of Sample................. BW From Boiler 4

Pretreatment......................... Sodium Cycle Softener

Feedwater Temp (F)..................................... 212
Feedwater Deoxygenation Method(s):
Mechanical.......................................
Oxygen Scavenger.................... Sodium Sulfite

Boiler Type................................. Water Tube
Steam Gauge Pressure (PSIG)......................... 220
Boiler Horsepower......................................
Boiler Output (PPH)............................ 98,000
Boiler Treatment:
pH Control.........................................
Phosphate.................sodium hexametaphosphate
Dispersant.........................................

Condensate pH Control.........................morpholine

Comments

NOTE: REMARKS AND RECOMMENDATIONS REFLECT CONDITIONS AT TIME OF SAMPLING AND MAY NOT APPLY TO CURRENT CONDITIONS.

REMARKS:

1. Thank you for your comment on Form 276 regarding blowdown. We are glad to see that you are investigating the cause of low TDS and causticity which you believe is caused by something other than excessive blowdown because you have already reduced blowdown to a "bare minimum". Let us know what you find out and please see Recommendation #1 below for suggestions on how P&A can help via this sample program.

2. Test agreement is good.

3. Control of treatment levels is good except for sulfite which is much too high.

Continued...

# BOILER SYSTEM WATER ANALYSIS PROGRAM

# FORT STEWART BUILDING 1412 BOILER 4

Sample Number . . . . BCSTEWBW
Date Sampled . . . . 01/10/95
Date Received . . . . 01/17/95
Date Analyzed . . . . 01/24/95
Date Report Issued . 01/27/95

## Boiler Water Analysis Report

| Test Description | P&A | Plant | Control |
|---|---|---|---|
| Specific Sx Description | Sample not full. | | |
| Total Hardness, ppm $CaCO_3$ | <2 | | |
| Filt Ortho Phos, ppm $PO_4$ | 47 | 45 | 30 - 60 |
| Tannin Color | | | |
| Polymer, ppm | | | N/A |
| Sulfite, ppm $Na_2SO_3$ | 690 | | 20 - 40 |
| P Alkalinity, ppm $CaCO_3$ | 460 | | |
| M Alkalinity, ppm $CaCO_3$ | | | |
| Causticity, ppm $OH^-$ | 160 | 161 | .20 - 200 |
| pH | 12.0 | 11.2 | |
| Neut Conductivity, mmhos | 2580 | | |
| Total Diss Solids, ppm | 1800 | 1540 | 3000 - 3500 |

### Specific Installation Information

Post.................................... Fort Stewart
City/State/Zip............ Fort Stewart, GA 31314-5000
Phone.................................. (912) 767-8931

Tester/Operator........................... Eddie Bryant
Building Sample is From........... Central Energy Plant
Description of Sample................. BW From Boiler 4

Pretreatment.................................. Resin

Feedwater Temp (F).............................. 212
Feedwater Deoxygenation Method(s):
Mechanical.......................................
Oxygen Scavenger................... Sodium Sulfite

Boiler Type............................... Water Tube
Steam Gauge Pressure (PSIG)...................... 220
Boiler Horsepower.................................
Boiler Output (PPH)........................... 98,000
Boiler Treatment:
pH Control.......................................
Phosphate.................sodium hexametaphosphate
Dispersant.......................................

Condensate pH Control........................morpholine

Comments

NOTE: REMARKS AND RECOMMENDATIONS REFLECT CONDITIONS AT TIME OF SAMPLING AND MAY NOT APPLY TO CURRENT CONDITIONS.

REMARKS:

1. Excellent test agreement overall! There is some discrepancy on TDS however, our result is 260 ppm higher than the plant's c about 14%. Sulfite was not reported by the plant.
2. Results show good control of phosphate and caustic dosage. Sulfite is highly overdosed. Blowdown is excessive based on lo TDS.

RECOMMENDATIONS:

1. Reduce sulfite dosage significantly.
2. Calibrate conductivity meter to improve test agreement for conductivity/TDS.
3. Reduce blowdown to allow TDS to rise into range.

REPORT PREPARED BY: J. Tiangco

A.3.2-12

## ECO NUMBER 3

**REDUCE SOOT BLOWING, INSTALL AN EXIT GAS TEMPERATURE INDICATOR ON THE WOOD-FIRED BOILER**

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-3
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-3 REDUCE SOOT BLOWING
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | |
|---|---|---|
| A. CONSTRUCTION COST | $ 208. | |
| B. SIOH | $ 13. | |
| C. DESIGN COST | $ 13. | |
| D. TOTAL COST (1A+1B+1C) | $ 234. | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | $ 234. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 0. | 15.08 | $ 0. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 1226. | $ 1643. | 14.88 | $ 24445. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 1226. | $ 1643. | | $ 24445. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 47.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 699.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 699.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 1690.

5. SIMPLE PAYBACK PERIOD (1G/4) .14 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 25145.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 107.46
(IF < 1 PROJECT DOES NOT QUALIFY)

WITH ECO'S 9A & 12A

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-3X
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-3 REDUCE SOOT BLOWING
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-15-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT
A. CONSTRUCTION COST $ 208.
B. SIOH $ 13.
C. DESIGN COST $ 13.
D. TOTAL COST (1A+1B+1C) $ 234.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 234.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 0. | 15.08 | $ 0. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 1060. | $ 1420. | 14.88 | $ 21136. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 1060. | $ 1420. | | $ 21136. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 47.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 699.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 699.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 1467.

5. SIMPLE PAYBACK PERIOD (1G/4) .16 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 21835.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 93.31
(IF < 1 PROJECT DOES NOT QUALIFY)

WITH ECO'S 9A, 12A & 12B

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-3Y
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-3 REDUCE SOOT BLOWING
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-15-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 208. | | |
| B. SIOH | $ 13. | | |
| C. DESIGN COST | $ 13. | | |
| D. TOTAL COST (1A+1B+1C) | $ 234. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 234. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 0. | 15.08 | $ 0. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 937. | $ 1256. | 14.88 | $ 18683. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 937. | $ 1256. | | $ 18683. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 47.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 699.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 699.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 1303.

5. SIMPLE PAYBACK PERIOD (1G/4) .18 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 19382.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 82.83
(IF < 1 PROJECT DOES NOT QUALIFY)

| | |
|---|---|
| **RS&H** | |
| SUBJECT | Fort Stewart<br>Reduce Soot Blowing |
| DESIGNER | G. Fallon |
| CHECKER | |
| AEP NO | 694 1331 002 |
| SHEET | OF |
| DATE | 2-8-96 |
| DATE | |

ECO No. 3 DECREASE SOOT BLOWING FREQUENCY

BOILER SOOT BLOWERS ARE OPERATED ONCE PER SHIFT REGARDLESS OF THE BOILER TUBE CLEANLINESS.

DIAMOND POWER (SOOT BLOWER MFG'R) CALCULATES 325 LBS OF STEAM ARE CONSUMMED WITH EACH OPERATION THERE 2 BLOWERS ON NO. 4 BOILER

CURRENT USE

$$\text{Energy} = 2\text{ blowers} \times 325\,\frac{\text{lb Steam}}{\text{blow}} \times 2\,\frac{\text{blows}}{\text{Shift}} \times 3\,\frac{\text{shift}}{\text{day}} \times 365\,\frac{\text{day}}{\text{YR}} = 1423500\,\frac{\text{lb Steam}}{\text{YR}}$$

$$1423500\,\frac{\text{lb steam}}{\text{YR}} \times (1199.6 - (60-32))\,\frac{\text{Btu}}{\text{lb}} \times \frac{1\text{ mBtu}}{10^6\text{ Btu}} = 1667.8\,\frac{\text{mBtu}}{\text{YR}}$$

$$\text{Fuel} = 1667.8\text{ mBtu/YR} \div 0.68\text{ boiler eff.} = \underline{2453\text{ mBtu/YR}}$$

$$\text{Water} = 1423500\,\frac{\text{lb steam}}{\text{YR}} \div 8.34\,\frac{\text{lb}}{\text{gal}} = \underline{170683\text{ GAL/YR}} \qquad \$95$$

DATA SHOWS EXIT GAS TEMPERATURE REMAINS NEARLY CONSTANT. IT IS THEREFORE REASONABLE TO ASSUME THAT THE BOILER ISN'T SUFFICIENTLY FOULED TO CAUSE EGT TO RISE. ASSUME THEREFORE THAT THE FREQUENCY COULD BE CUT IN HALF.

ANNUAL SAVINGS WOULD BE ABOUT 50%

ANNUAL SAVINGS

$$\text{Fuels} = 2453\text{ mBtu/YR} \times 0.50 = \boxed{1226\text{ mBtu/YR}}$$

$$\text{Water} = 170683\text{ GAL/YR} \times 0.50 = \underline{85341\text{ GAL/YR}}$$

$$\text{Water \$} = 85341\,\frac{\text{GAL}}{\text{YR}} \times \$0.5562/1000\text{ GAL} = \boxed{\$47/\text{YR}}$$

# CONSTRUCTION COST ESTIMATE

| | | | |
|---|---|---|---|
| Project: | Reduce Soot Blowing | RS&H No.: | 694-1331-002 |
| Location: | Fort Stewart, GA | Date: | 02/14/96 |
| Basis: | Schematic Design | Estimator: | W.T.Todd |
| ECO No.: | 3 | Filename: | EST-3.WB2 |

| ITEM DESCRIPTION | QUANTITY | | MATERIAL/EQUIP | | LABOR | | TOTAL COST | SOURCE | |
|---|---|---|---|---|---|---|---|---|---|
| | No. | Unit | $/Unit | Total | $/Unit | Total | | Material | Labor |
| Thermometer well | 1 | Ea | 29 | 29 | 18.5 | 19 | 48 | MMp167 | MMp167 |
| Thermometer | 1 | Ea | 133 | 133 | 7.55 | 8 | 141 | MMp313 | MMp313 |
| Subtotal Bare Costs | | | | 162 | | 27 | $189 | | |
| Retrofit Cost Factors | | | 0% | 0 | 0% | 0 | 0 | MMp6 | MMp6 |
| Subtotal | | | | 162 | | 27 | 189 | | |
| City Cost Index (Sav. GA) | | | 0% | 0 | -44% | -12 | (12) | MMp533 | MMp533 |
| Subtotal | | | | 162 | | 15 | 177 | | |
| OH & Profit Markups | | | 10% | 16 | 53% | 8 | 24 | MMp7 | MMp475 |
| Subtotal | | | | 178 | | 23 | 201 | | |
| Sales Taxes | | | 4.0% | 7 | | NA | 7 | MMp476 | |
| Total Construction Cost | | | | 185 | | 23 | 208 | | |
| Design Fee | | | | NA | 6.0% | 12 | 12 | | |
| SIOH | | | | NA | 6.0% | 12 | 12 | | |
| Subtotal | | | | 185 | | 47 | 232 | | |
| Contingency | | | 0% | 0 | 0% | 0 | 0 | MEp6 | MEp6 |
| Total Project Cost | | | | 185 | | 47 | $232 | | |

LEGEND:

MMp### 1996 Means Mechanical Cost Data, page ###.

## ECO NUMBER 4

## REPAIR HTW AND STEAM LEAKS IN THE CEP AND THE SEP

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-4
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-4 REPAIR LEAKS IN THE CEP AND THE SEP
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT
A. CONSTRUCTION COST $ 4057.
B. SIOH $ 244.
C. DESIGN COST $ 244.
D. TOTAL COST (1A+1B+1C) $ 4545.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 4545.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 2. | $ 21. | 15.08 | $ 311. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 1091. | $ 1462. | 14.88 | $ 21754. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 1093. | $ 1483. | | $ 22064. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 160.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 2381.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 2381.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 1643.

5. SIMPLE PAYBACK PERIOD (1G/4) 2.77 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 24445.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 5.38
(IF < 1 PROJECT DOES NOT QUALIFY)

WITH ECO'S 9A & 12A

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-4X
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-4 REPAIR LEAKS IN THE CEP AND THE SEP
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-15-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 4057. | | |
| B. SIOH | $ 244. | | |
| C. DESIGN COST | $ 244. | | |
| D. TOTAL COST (1A+1B+1C) | $ 4545. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 4545. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 2. | $ 21. | 15.08 | $ 311. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 943. | $ 1264. | 14.88 | $ 18803. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 945. | $ 1284. | | $ 19113. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 160.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 2381.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 2381.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 1444.

5. SIMPLE PAYBACK PERIOD (1G/4) 3.15 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 21494.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 4.73
(IF < 1 PROJECT DOES NOT QUALIFY)

WITH ECO'S 9A, 12A & 12B

LIFE CYCLE COST ANALYSIS SUMMARY                STUDY: ECO-4Y
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)     LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-4 REPAIR LEAKS IN THE CEP AND THE SEP
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-15-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 4057. | | |
| B. SIOH | $ 244. | | |
| C. DESIGN COST | $ 244. | | |
| D. TOTAL COST (1A+1B+1C) | $ 4545. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 4545. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 2. | $ 21. | 15.08 | $ 311. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 834. | $ 1118. | 14.88 | $ 16629. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 836. | $ 1138. | | $ 16940. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 160.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 2381.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 2381.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 1298.

5. SIMPLE PAYBACK PERIOD (1G/4) 3.50 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 19321.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 4.25
(IF < 1 PROJECT DOES NOT QUALIFY)

**RS&H**

SUBJECT: FORT STEWART
Repair CEP & SEP Leaks
DESIGNER: W. Todd
CHECKER:

AEP NO: 694 1331 002
SHEET: 1 OF
DATE: 2-12-96
DATE:

ECO-4 REPAIR HTW AND STEAM LEAKS IN THE CEP AND SEP

The quantities of HTW losses are listed below and the calculations can be found on the following pages:

Misc. CEP Leaks = 0.207 gpm = 298 GPD

These leaks are all from valves stems, fittings and pump glands. It is hard for the pump glands to handle the high system operating pressure so we assumed that only about 50% of these leaks could be repaired.

Boiler No. 4 Leaks = 0.232 gpm = 334 GPD

These leaks include 3 faulty steam traps and two blowdown valves. Assume new steam traps and valves will reduce these leaks by about 90%.

Misc. SEP Leaks = 0.233 gpm = 336 GPD

These leaks are mainly due to leaking blowdown valves on the cascade heaters. Assume replacing the blowdown valves and tightening the other valves will eliminate 100% of these leaks.

Current HTW Losses = $(298 + 334 + 336)\ \text{GPD} \times 365\ \frac{\text{day}}{\text{YR}} = 353320\ \frac{\text{Gal}}{\text{YR}}$

Proposed HTW Losses = $(298 \times 0.5 + 334 \times 0.1)\ \text{GPD} \times 365\ \frac{\text{day}}{\text{YR}} = 66580\ \frac{\text{Gal}}{\text{YR}}$

| | |
|---|---|
| SUBJECT FORT STEWART REPAIR CEP & SEP LEAKS | AEP NO 694 1221 002 |
| | SHEET 2 OF |
| DESIGNER W. TODD | DATE 2-12-96 |
| CHECKER | DATE |

ECO-4 SUMMARY

ANNUAL SAVINGS

HEATING FUELS = 1344 - 253 = $\boxed{1091 \text{ MBtu/YR}}$

ELECTRICITY = 1.8 - 0.3 = $\boxed{1.5 \text{ MBtu/YR}}$

WATER = \$197 - \$27 = $\boxed{\$160\text{/YR}}$

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. | |
| AEP Number: | 694-1331-002 | Designer: | W. T. Todd |
| Project: | Existing Leaks in the CEP and SEP | Date: | 02/12/96 |
| ECO Number: | 4 | | |

Assumptions:

| | | | |
|---|---|---|---|
| 1. | HTW temperature | 380 | °F |
| 2. | Make-up water temperature | 70 | °F |
| 3. | Boiler efficiency | 68% | |
| 4. | Pump head (from record drawings) | 300 | Ft H20 |
| 5. | Pump efficiency (from record drawings | 72% | |
| 6. | Motor efficiency | 90% | |
| 7. | Average heating fuel cost | $1.34 | /MBtu |
| 8. | Electricity cost | $0.0469 | /kWh |
| 9. | Water cost | $0.5562 | /kGallons |

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

353320 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 914.0 MBtu/Yr

Heating Fuel Use = 914.0 MBtu/yr / 0.68 = 1344.1 MBtu/Yr

Heating Fuel Cost = 1344.1 MBtu/yr x $1.34 /MBtu = $1,801 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$\text{BHP} = \frac{0.67 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.071 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.071 BHP / 0.90 x 0.746 kW/HP = 0.059 kW

Electricity Use = 0.059 kW x 8760 Hr/Yr = 514 kWh/Yr

Electricity Use = 514 kWh/Yr x 0.003413 MBtu/kWh = 1.75 MBtu/Yr

Electricity Cost = 514 kWh/Yr x $0.0469 /kWh = $24 /Year

Water Cost:

353320 Gal/Yr x $0.5562 /kGal = $197 /Year

Total Utility Cost:

| | | |
|---|---|---|
| Heating Fuel Cost | $1,801 | /Year |
| Pumping (Elec) Cost | $24 | /Year |
| Water Cost | $197 | /Year |
| Total Utility Cost | $2,022 | /Year |

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. | |
| AEP Number: | 694-1331-002 | Designer: | W. T. Todd |
| Project: | Repair Leaks in the CEP and SEP | Date: | 02/12/96 |
| ECO Number: | 4 | | |

Assumptions:

| | | | |
|---|---|---|---|
| 1. | HTW temperature | 380 | °F |
| 2. | Make-up water temperature | 70 | °F |
| 3. | Boiler efficiency | 68% | |
| 4. | Pump head (from record drawings) | 300 | Ft H20 |
| 5. | Pump efficiency (from record drawings | 72% | |
| 6. | Motor efficiency | 90% | |
| 7. | Average heating fuel cost | $1.34 | /MBtu |
| 8. | Electricity cost | $0.0469 | /kWh |
| 9. | Water cost | $0.5562 | /kGallons |

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

66580 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 172.2 MBtu/Yr

Heating Fuel Use = 172.2 MBtu/yr / 0.68 = 253.3 MBtu/Yr

Heating Fuel Cost = 253.3 MBtu/yr x $1.34 /MBtu = $339 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$BHP = \frac{0.13 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.013 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency ) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.013 BHP / 0.90 x 0.746 kW/HP = 0.011 kW

Electricity Use = 0.011 kW x 8760 Hr/Yr = 97 kWh/Yr

Electricity Use = 97 kWh/Yr x 0.003413 MBtu/kWh = 0.33 MBtu/Yr

Electricity Cost = 97 kWh/Yr x $0.0469 /kWh = $5 /Year

Water Cost:

66580 Gal/Yr x $0.5562 /kGal = $37 /Year

Total Utility Cost:

| | | |
|---|---|---|
| Heating Fuel Cost | $339 | /Year |
| Pumping (Elec) Cost | $5 | /Year |
| Water Cost | $37 | /Year |
| Total Utility Cost | $381 | /Year |

RS&H

SUBJECT FORT STEWART
CEP Misc. Leaks
DESIGNER W. Todd
CHECKER

AEP NO 694 1331 002
SHEET 1 OF 2
DATE 2-2-96
DATE

# CEP MISCELLANEOUS LEAKS

Valves & Fittings:

| | Leak Rate Estimate |
|---|---|
| **Cascade Heater No. 1** | |
| - Valve to top of sight glass leaking steam | 2 drop/sec |
| - Valve on top left of heater leaking steam | 2 " |
| **Cascade Heater No. 2** | |
| - Valve on bottom left of heater leaking steam | 2 " |
| **Cascade Heater No. 3** | |
| - Valve on top of sight glass leaking steam | 2 " |
| **Deaerator Tank** | |
| - Strainer next to control valve leaking steam and about 3 drops/second HTW. | 5 " |
| - Valve above stairs leaking steam | 2 " |
| - Vent to outside blowing steam (intermittant) | 2 " |
| Total valves & fittings leaks | 17 drops/sec |

$$17 \text{ drops/second} \times 2.5\times10^{-3} \frac{gpm}{d/s} = \underline{0.042 \text{ gal/min}}$$

HTW Zone Pumps:

- P-4 & P-5 ~ 1drop / 4 seconds = 0.0006 GPM
- P-10 ~ steady 1/8" stream * = 0.109 GPM
- P-11 ~ Intermittant 1/8" stream* = 0.054 GPM

| SUBJECT | Fort Stewart | AEP NO | 694 1331 002 |
|---|---|---|---|
| | CEP Misc. Leaks | SHEET | 2 OF 2 |
| DESIGNER | W. Todd | DATE | 2-2-96 |
| CHECKER | | DATE | |

Pumps (continued)

- P-23 & P-24 ~ 2 drops / 3 seconds = 0.0017 GPM

* A 1/8" stream was measured and timed and found to be ~1.75 cups/min ÷ 16 $\frac{\text{cups}}{\text{gal}}$ ≈ 0.109 GPM

Total leaks from HTW Pumps = 0.165 GPM

Total Miscellaneous CEP Leaks:

| | |
|---|---|
| Valves & Fittings | 0.042 GPM |
| HTW Zone Pumps | 0.165 GPM |
| Total = | 0.207 GPM |

## Central Energy Plant (CEP) Leak Test #4 Boiler

On November 30, 1995 a leak test was conducted at CEP to determine the extent of the leaks associated with Boiler No.4. A significant amount of steam continually vents from the No.4 blowdown tank. To quantify this loss, a CEP leak test would be conducted with the No.4 boiler configured in as a "tight" a mode as possible, and then a second test would be conducted with No.4 in a "normal" (leaky) configuration. The difference in the test results would be the leaks due to No. 4's normal configuration.

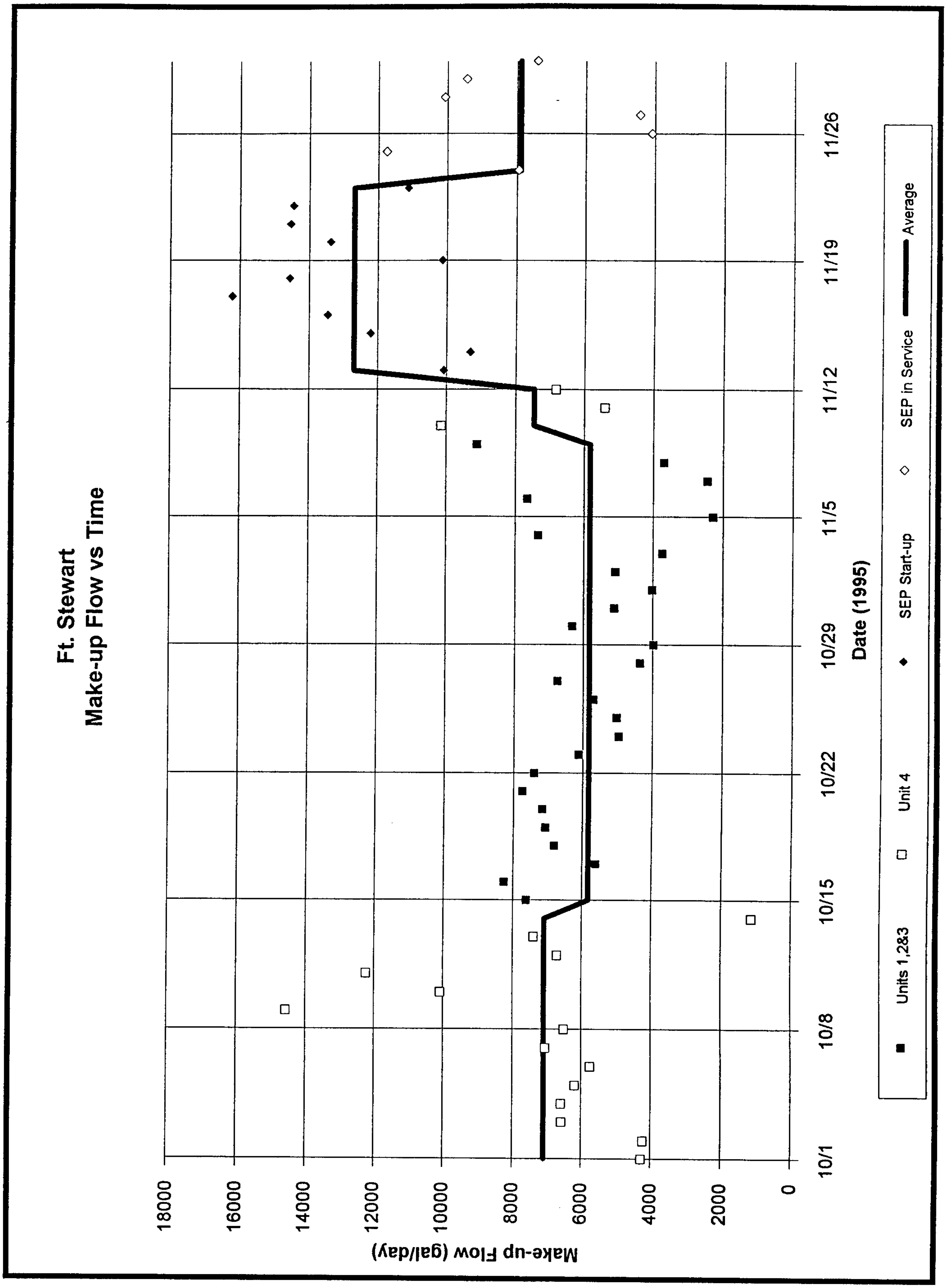
The leak test consists of measuring the make-up water required to maintain constant heater levels over an 8 hour period. Unfortunately, the test results showed no heater level changes over the 6 hour test period when a 6-7 inch change in the gauge glass level was expected. This testing technique has yielded results in the past. No explanation for the lack of results was determined; however, improper system valving is strongly suspected.

Configuring the boiler in as tight a configuration as possible stopped the blowdown tank steam venting. Leaking steam traps in the main steam line, the soot blower warm-up line, and in the boiler feed pump turbine line are the sources of the steam venting. Furthermore, the rear water wall header blowdown valves are leaking slightly. This leak was so small that only warm water entered the blow down tank.

A graph (enclosed) of the daily make-up consumption data shows a wide scattering of data, perhaps lending credence to the suspicion that observing heater tank levels over a short period of time (8 hours) yields uncertain results. However, when averaged over longer periods of time (weeks), yields more reliable results. The graph shows the daily make-up consumption (DMC) prior to October 15, 1995 averaged about 7000 gpd (4.86 gpm) while unit 4 alone was operating. During the period October 15 through November 10, 1995 unit 4 was shut down and units 1,2 and 3 were operating, and the DMC fell to 5900 gpd (4.10 gpm). This reduction in DMC can be attributed to two principal causes; 1) the general leaky state of unit No. 4; and 2) the required consumption of steam for sootblowing. The magnitude of the change 1100 gpd (0.764 gpm) seems reasonable. The fact that the consumption returned to the original levels when 4 boiler was returned to service implies that some of the leaks are in fact related to unit No. 4.

### No. 4 Boiler Operation Recommendations

1. Repair steam trap leaks.
2. Reduce soot blowing frequency. Change from a time based operation to an exit gas temperature based operation.
3. Reduce blow down frequency to maintain American Boiler Manufacturers Association standard of 3500 ppm total dissolved solids.


Ft. Stewart
Make-up Flow vs Time
Make-up Flow (gal/day)
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
10/1
10/8
10/15
10/22
10/29
11/5
11/12
11/19
11/26
Date (1995)
Units 1,2&3
Unit 4
SEP Start-up
SEP in Service
Average

Satellite Energy Plant (SEP) Leak test.

On November 29, 1995 the SEP was tested for system leaks. The testing procedure consists of stopping all steam flow to, and condensate return flow from, the SEP, and measuring the decrease in the level of the two cascade heaters in the SEP. By calculating the volume change in the heaters, a leak rate may be determined.

| | | | | | |
|---|---|---|---|---|---|
| Time (EST) | 9:46 | 10:34 | 11:13 | 11:37 | 11:48 |
| Level (in) | 14.3 | 14.3 | 14.3 | 14.3 | 14.3 |
| Temp (°F) | 375 | 360 | 340 | 335 | 330 |
| Pres. (psig) | 190 | 140 | 115 | 105 | 100 |

The data from the 2 hour test indicated that the water level in the heaters never changed while the circulating hot water showed a -45° temperature change and a -90 psig pressure change. It was concluded therefore the SEP system was "tight".

It is important to note however that the testing method used is quite crude over the short time period of the test. The two, 4000 gallon, cascade heaters are connected by symmetrical piping assuring "equal" water levels in both heaters. A one inch change in water level, at normal operating level, would be equivalent to 140 gallons of water. The leaks found and measured during the test are tabulated below.

| Location | Amount (gpm) |
|---|---|
| East Heater gauge glass | $2.23 \times 10^{-4}$ |
| East Heater Steam Stop valve | $2.11 \times 10^{-3}$ |
| West Heater Equalization valve | $1.00 \times 10^{-3}$ |
| HTWS Check Valve | 0.03 |
| Both Heaters blow down valves | 0.2 |
| **TOTAL** | **0.233** |

The total amount of water lost during the test is 0.233 gpm x 122 min. = 29 gals., or approximately 0.2 inches on the gauge glass. With normal, slow, level swings (generally attributable to sloshing) between the tanks, this leak rate is barley detectable in the sight glass over the time span of the test. Because of the large heater storage capacity, a longer test period is warranted. In the future this test could be a reasonable leak detection and quantification method at the SEP if conducted over longer testing periods. The best time for the test would be when the heat load from the SEP is minimal, perhaps on a warm day after a cool night.

# CONSTRUCTION COST ESTIMATE

| | | | |
|---|---|---|---|
| Project: | Repair HTW Leaks in the CEP and SEP | RS&H No.: | 694-1331-002 |
| Location: | Fort Stewart, GA | Date: | 02/14/96 |
| Basis: | Schematic Design | Estimator: | W.T.Todd |
| ECO No.: | 4 | Filename: | EST-4.WB2 |

| ITEM DESCRIPTION | QUANTITY | | MATERIAL/EQUIP | | LABOR | | TOTAL COST | SOURCE | |
|---|---|---|---|---|---|---|---|---|---|
| | No. | Unit | $/Unit | Total | $/Unit | Total | | Material | Labor |
| Travel time to bldgs. | 0.5 | hr | | 0 | 30.3 | 15 | 15 | | (1) |
| Repair/tighten valves | 2.8 | hr | | 0 | 30.3 | 83 | 83 | | (2) |
| Remove Steam Traps | 3 | Ea | | 0 | 34.5 | 104 | 104 | | MMp264 |
| Steam Trap, 1", 600 lb | 3 | Ea | 660 | 1980 | 34.5 | 104 | 2,084 | MMp264 | MMp264 |
| Remove valves | 4 | Ea | | 0 | 52.8 | 211 | 211 | | MMp191 |
| 2" gate valve, 250 lb | 4 | Ea | 256 | 1024 | 52.8 | 211 | 1,235 | MMp191 | MMp191 |
| Subtotal Bare Costs | | | | 3004 | | 728 | $3,732 | | |
| Retrofit Cost Factors | | | 0% | 0 | 0% | 0 | 0 | MMp6 | MMp6 |
| Subtotal | | | | 3004 | | 728 | 3,732 | | |
| City Cost Index (Sav. GA) | | | 0% | 0 | -44% | -322 | (322) | MMp533 | MMp533 |
| Subtotal | | | | 3004 | | 406 | 3,410 | | |
| OH & Profit Markups | | | 10% | 300 | 53% | 215 | 515 | MMp7 | MMp475 |
| Subtotal | | | | 3304 | | 621 | 3,925 | | |
| Sales Taxes | | | 4.0% | 132 | | NA | 132 | MMp476 | |
| Total Construction Cost | | | | 3436 | | 621 | 4,057 | | |
| Design Fee | | | | NA | 6.0% | 243 | 243 | | |
| SIOH | | | | NA | 6.0% | 243 | 243 | | |
| Subtotal | | | | 3436 | | 1107 | 4,543 | | |
| Contingency | | | 0% | 0 | 0% | 0 | 0 | MEp6 | MEp6 |
| Total Project Cost | | | | 3436 | | 1107 | $4,543 | | |

LEGEND:

(1) Estimate 30 minutes for CEP to SEP round trip.

(2) Estimate 15 minutes per valve for 11 valves.

MMp### 1996 Means Mechanical Cost Data, page ###.

## Installing Contractor's Overhead & Profit

Below are the **average** installing contractor's percentage mark-ups applied to base labor rates to arrive at typical billing rates.

**Column A:** Labor rates are based on union wages averaged for 30 major U.S. cities. Base rates including fringe benefits are listed hourly and daily. These figures are the sum of the wage rate and employer-paid fringe benefits such as vacation pay, employer-paid health and welfare costs, pension costs, plus appropriate training and industry advancement funds costs.

**Column B:** Workers' Compensation rates are the national average of state rates established for each trade.

**Column C:** Column C lists average fixed overhead figures for all trades. Included are Federal and State Unemployment costs set at 7.3%; Social Security Taxes (FICA) set at 7.65%; Builder's Risk Insurance costs set at 0.34%; and Public Liability costs set at 1.55%. All the percentages except those for Social Security Taxes vary from state to state as well as from company to company.

**Columns D and E:** Percentages in Columns D and E are based on the presumption that the installing contractor has annual billing of $500,000 and up. Overhead percentages may increase with smaller annual billing. The overhead percentages for any given contractor may vary greatly and depend on a number of factors, such as the contractor's annual volume, engineering and logistical support costs, and staff requirements. The figures for overhead and profit will also vary depending on the type of job, the job location, and the prevailing economic conditions. All factors should be examined very carefully for each job.

**Column F:** Column F lists the total of Columns B, C, D, and E.

**Column G:** Column G is Column A (hourly base labor rate) multiplied by the percentage in Column F (O&P percentage).

**Column H:** Column H is the total of Column A (hourly base labor rate) plus Column G (Total O&P).

**Column I:** Column I is Column H multiplied by eight hours.

| | | A | | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Base Rate Incl. Fringes | | Workers' Comp. Ins. | Average Fixed Overhead | Overhead | Profit | Total Overhead & Profit | | Rate with O & P | |
| Abbr. | Trade | Hourly | Daily | | | | | % | Amount | Hourly | Daily |
| Skwk | Skilled Workers Average (35 trades) | $25.95 | $207.60 | 20.2% | 16.8% | 13.0% | 10% | 60.0% | $15.55 | $41.50 | $332.00 |
| | Helpers Average (5 trades) | 19.25 | 154.00 | 21.4 | | 11.0 | | 59.2 | 11.40 | 30.65 | 245.20 |
| | Foreman Average, Inside ($.50 over trade) | 26.45 | 211.60 | 20.2 | | 13.0 | | 60.0 | 15.85 | 42.30 | 338.40 |
| | Foreman Average, Outside ($2.00 over trade) | 27.95 | 223.60 | 20.2 | | 13.0 | | 60.0 | 16.75 | 44.70 | 357.60 |
| Clab | Common Building Laborers | 19.80 | 158.40 | 21.9 | | 11.0 | | 59.7 | 11.80 | 31.60 | 252.80 |
| Asbe | Asbestos Workers | 28.55 | 228.40 | 19.7 | | 16.0 | | 62.5 | 17.85 | 46.40 | 371.20 |
| Boil | Boilermakers | 30.05 | 240.40 | 17.7 | | 16.0 | | 60.5 | 18.20 | 48.25 | 386.00 |
| Bric | Bricklayers | 25.90 | 207.20 | 19.4 | | 11.0 | | 57.2 | 14.80 | 40.70 | 325.60 |
| Brhe | Bricklayer Helpers | 20.00 | 160.00 | 19.4 | | 11.0 | | 57.2 | 11.45 | 31.45 | 251.60 |
| Carp | Carpenters | 25.20 | 201.60 | 21.9 | | 11.0 | | 59.7 | 15.05 | 40.25 | 322.00 |
| Cefi | Cement Finishers | 24.35 | 194.80 | 12.8 | | 11.0 | | 50.6 | 12.30 | 36.65 | 293.20 |
| Elec | Electricians | 29.30 | 234.40 | 8.0 | | 16.0 | | 50.8 | 14.90 | 44.20 | 353.60 |
| Elev | Elevator Constructors | 30.05 | 240.40 | 9.6 | | 16.0 | | 52.4 | 15.75 | 45.80 | 366.40 |
| Eqhv | Equipment Operators, Crane or Shovel | 26.75 | 214.00 | 12.9 | | 14.0 | | 53.7 | 14.35 | 41.10 | 328.80 |
| Eqmd | Equipment Operators, Medium Equipment | 25.70 | 205.60 | 12.9 | | 14.0 | | 53.7 | 13.80 | 39.50 | 316.00 |
| Eqlt | Equipment Operators, Light Equipment | 24.70 | 197.60 | 12.9 | | 14.0 | | 53.7 | 13.25 | 37.95 | 303.60 |
| Eqol | Equipment Operators, Oilers | 21.90 | 175.20 | 12.9 | | 14.0 | | 53.7 | 11.75 | 33.65 | 269.20 |
| Eqmm | Equipment Operators, Master Mechanics | 27.55 | 220.40 | 12.9 | | 14.0 | | 53.7 | 14.80 | 42.35 | 338.80 |
| Glaz | Glaziers | 24.90 | 199.20 | 16.0 | | 11.0 | | 53.8 | 13.40 | 38.30 | 306.40 |
| Lath | Lathers | 24.95 | 199.60 | 13.5 | | 11.0 | | 51.3 | 12.80 | 37.75 | 302.00 |
| Marb | Marble Setters | 25.65 | 205.20 | 19.4 | | 11.0 | | 57.2 | 14.65 | 40.30 | 322.40 |
| Mill | Millwrights | 26.55 | 212.40 | 13.2 | | 11.0 | | 51.0 | 13.55 | 40.10 | 320.80 |
| Mstz | Mosaic & Terrazzo Workers | 25.25 | 202.00 | 11.0 | | 11.0 | | 48.8 | 12.30 | 37.55 | 300.40 |
| Pord | Painters, Ordinary | 22.95 | 183.60 | 16.8 | | 11.0 | | 54.6 | 12.55 | 35.50 | 284.00 |
| Psst | Painters, Structural Steel | 23.95 | 191.60 | 62.5 | | 11.0 | | 100.3 | 24.00 | 47.95 | 383.60 |
| Pape | Paper Hangers | 23.30 | 186.40 | 16.8 | | 11.0 | | 54.6 | 12.70 | 36.00 | 288.00 |
| Pile | Pile Drivers | 25.35 | 202.80 | 33.6 | | 16.0 | | 76.4 | 19.35 | 44.70 | 357.60 |
| Plas | Plasterers | 24.20 | 193.60 | 17.4 | | 11.0 | | 55.2 | 13.35 | 37.55 | 300.40 |
| Plah | Plasterer Helpers | 20.15 | 161.20 | 17.4 | | 11.0 | | 55.2 | 11.10 | 31.25 | 250.00 |
| Plum | Plumbers | 30.05 | 240.40 | 10.2 | | 16.0 | | 53.0 | 15.95 | 46.00 | 368.00 |
| Rodm | Rodmen (Reinforcing) | 27.75 | 222.00 | 36.3 | | 14.0 | | 77.1 | 21.40 | 49.15 | 393.20 |
| Rofc | Roofers, Composition | 22.55 | 180.40 | 37.4 | | 11.0 | | 75.2 | 16.95 | 39.50 | 316.00 |
| Rots | Roofers, Tile & Slate | 22.60 | 180.80 | 37.4 | | 11.0 | | 75.2 | 17.00 | 39.60 | 316.80 |
| Rohe | Roofers, Helpers (Composition) | 15.95 | 127.60 | 37.4 | | 11.0 | | 75.2 | 12.00 | 27.95 | 223.60 |
| Shee | Sheet Metal Workers | 28.95 | 231.60 | 13.8 | | 16.0 | | 56.6 | 16.40 | 45.35 | 362.80 |
| Spri | Sprinkler Installers | 31.30 | 250.40 | 10.4 | | 16.0 | | 53.2 | 16.65 | 47.95 | 383.60 |
| Stpi | Steamfitters or Pipefitters | 30.30 | 242.40 | 10.2 | | 16.0 | | 53.0 | 16.05 | 46.35 | 370.80 |
| Ston | Stone Masons | 25.90 | 207.20 | 19.4 | | 11.0 | | 57.2 | 14.80 | 40.70 | 325.60 |
| Sswk | Structural Steel Workers | 27.85 | 222.80 | 46.4 | | 14.0 | | 87.2 | 24.30 | 52.15 | 417.20 |
| Tilf | Tile Layers | 25.05 | 200.40 | 11.0 | | 11.0 | | 48.8 | 12.20 | 37.25 | 298.00 |
| Tilh | Tile Layers Helpers | 20.30 | 162.40 | 11.0 | | 11.0 | | 48.8 | 9.90 | 30.20 | 241.60 |
| Trlt | Truck Drivers, Light | 20.35 | 162.80 | 17.0 | | 11.0 | | 54.8 | 11.15 | 31.50 | 252.00 |
| Trhv | Truck Drivers, Heavy | 20.70 | 165.60 | 17.0 | | 11.0 | | 54.8 | 11.35 | 32.05 | 256.40 |
| Sswl | Welders, Structural Steel | 27.85 | 222.80 | 46.4 | | 14.0 | | 87.2 | 24.30 | 52.15 | 417.20 |
| Wrck | *Wrecking | 19.80 | 158.40 | 44.8 | | 11.0 | | 82.6 | 16.35 | 36.15 | 289.20 |

*Not included in Averages.

# City Cost Indexes

| DIVISION | | FLORIDA | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MIAMI | | | ORLANDO | | | PANAMA CITY | | | PENSACOLA | | | ST. PETERSBURG | | | TALLAHASSEE | | |
| | | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL |
| 2 | SITE WORK | 110.3 | 72.8 | 81.5 | 125.3 | 85.9 | 95.0 | 141.6 | 83.4 | 96.9 | 138.9 | 85.9 | 98.1 | 126.2 | 85.6 | 95.0 | 125.7 | 85.2 | 94.6 |
| 031 | CONCRETE FORMWORK | 94.2 | 71.0 | 74.5 | 97.3 | 71.6 | 75.5 | 95.8 | 37.8 | 46.6 | 84.5 | 69.7 | 72.0 | 94.1 | 64.8 | 69.3 | 97.3 | 53.0 | 59.7 |
| 032 | CONCRETE REINFORCEMENT | 95.1 | 72.5 | 82.4 | 95.1 | 79.0 | 86.0 | 99.3 | 64.5 | 79.7 | 101.5 | 64.9 | 81.0 | 98.5 | 74.3 | 84.9 | 95.1 | 65.2 | 78.3 |
| 033 | CAST IN PLACE CONCRETE | 91.5 | 75.4 | 84.6 | 88.7 | 78.0 | 84.1 | 95.2 | 43.0 | 72.9 | 95.2 | 69.0 | 84.0 | 101.4 | 70.2 | 88.1 | 91.7 | 58.4 | 77.5 |
| 3 | CONCRETE | 87.4 | 74.3 | 80.8 | 86.3 | 76.7 | 81.4 | 95.0 | 46.6 | 70.5 | 93.5 | 70.1 | 81.7 | 92.6 | 70.1 | 81.2 | 87.7 | 59.2 | 73.3 |
| 4 | MASONRY | 76.9 | 70.2 | 72.8 | 77.4 | 75.6 | 76.2 | 84.9 | 37.4 | 55.4 | 82.6 | 67.6 | 73.3 | 119.2 | 66.9 | 86.7 | 83.6 | 52.6 | 64.4 |
| 5 | METALS | 98.8 | 93.5 | 96.8 | 107.9 | 95.0 | 103.0 | 97.2 | 75.1 | 88.9 | 97.1 | 89.6 | 94.3 | 101.0 | 92.4 | 97.7 | 99.2 | 88.1 | 95.0 |
| 6 | WOOD & PLASTICS | 88.6 | 72.7 | 80.6 | 94.5 | 71.1 | 82.8 | 92.9 | 38.3 | 65.6 | 80.1 | 71.1 | 75.6 | 90.8 | 65.2 | 78.0 | 94.5 | 51.6 | 73.0 |
| 7 | THERMAL & MOISTURE PROTECTION | 99.6 | 74.6 | 88.0 | 96.6 | 75.6 | 86.9 | 96.9 | 38.3 | 69.9 | 96.6 | 66.9 | 82.9 | 96.3 | 63.1 | 81.0 | 96.6 | 58.8 | 79.1 |
| 8 | DOORS & WINDOWS | 95.9 | 69.5 | 89.5 | 98.1 | 68.2 | 90.9 | 95.7 | 35.2 | 81.2 | 95.7 | 66.5 | 88.7 | 96.8 | 60.4 | 88.0 | 98.1 | 53.9 | 87.4 |
| 092 | LATH, PLASTER & GYPSUM BOARD | 101.0 | 72.5 | 82.5 | 101.6 | 70.8 | 81.7 | 99.7 | 36.9 | 59.0 | 94.5 | 70.9 | 79.2 | 98.9 | 64.8 | 76.8 | 101.6 | 50.7 | 68.6 |
| 095 | ACOUSTICAL TREATMENT & WOOD FLOORING | 102.4 | 72.5 | 83.0 | 102.4 | 70.8 | 82.0 | 96.6 | 36.9 | 58.0 | 96.6 | 70.9 | 79.9 | 98.0 | 64.8 | 76.5 | 102.4 | 50.7 | 68.9 |
| 096 | FLOORING & CARPET | 121.8 | 75.3 | 110.7 | 113.0 | 74.9 | 103.8 | 112.3 | 24.6 | 91.3 | 106.7 | 68.0 | 97.4 | 111.4 | 67.8 | 100.9 | 113.0 | 49.7 | 97.8 |
| 099 | PAINTING & WALL COVERINGS | 100.9 | 70.1 | 83.0 | 104.2 | 77.6 | 88.7 | 104.2 | 34.5 | 63.7 | 104.2 | 78.5 | 89.3 | 104.2 | 65.4 | 81.6 | 104.2 | 55.7 | 76.0 |
| 9 | FINISHES | 108.6 | 71.4 | 89.7 | 107.7 | 72.7 | 89.9 | 107.2 | 34.4 | 70.2 | 104.5 | 70.5 | 87.2 | 106.0 | 65.3 | 85.3 | 107.7 | 51.9 | 79.3 |
| 10-14 | TOTAL DIV. 10-14 | 100.0 | 81.8 | 96.1 | 100.0 | 83.9 | 96.6 | 100.0 | 65.4 | 92.6 | 100.0 | 73.3 | 94.3 | 100.0 | 76.8 | 95.1 | 100.0 | 74.0 | 94.5 |
| 15 | MECHANICAL | 100.0 | 72.9 | 88.0 | 100.0 | 70.8 | 87.1 | 100.0 | 34.6 | 71.1 | 100.0 | 68.8 | 86.2 | 100.0 | 68.7 | 86.2 | 100.0 | 54.8 | 80.0 |
| 16 | ELECTRICAL | 98.0 | 84.9 | 89.3 | 98.0 | 63.0 | 74.6 | 96.3 | 47.1 | 63.5 | 101.8 | 63.4 | 76.2 | 98.5 | 68.1 | 78.2 | 98.0 | 58.3 | 71.5 |
| 1-16 | WEIGHTED AVERAGE | 97.5 | 76.7 | 87.4 | 99.2 | 75.1 | 87.6 | 99.2 | 48.1 | 74.5 | 98.8 | 71.8 | 85.7 | 101.0 | 71.8 | 86.9 | 98.5 | 62.1 | 80.9 |

| DIVISION | | FLORIDA | | | GEORGIA | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | TAMPA | | | ALBANY | | | ATLANTA | | | AUGUSTA | | | COLUMBUS | | | MACON | | |
| | | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL |
| 2 | SITE WORK | 126.9 | 85.6 | 95.1 | 110.4 | 74.2 | 82.5 | 114.3 | 92.8 | 97.8 | 110.2 | 91.5 | 95.8 | 110.4 | 74.3 | 82.6 | 111.6 | 91.9 | 96.5 |
| 031 | CONCRETE FORMWORK | 97.3 | 64.9 | 69.8 | 96.9 | 50.8 | 57.8 | 98.0 | 70.3 | 74.5 | 94.5 | 61.8 | 66.7 | 96.9 | 50.4 | 57.4 | 95.9 | 65.9 | 70.5 |
| 032 | CONCRETE REINFORCEMENT | 95.1 | 74.3 | 83.4 | 95.1 | 76.4 | 84.6 | 98.5 | 77.5 | 86.7 | 104.0 | 69.1 | 84.4 | 95.1 | 76.4 | 84.6 | 97.4 | 76.7 | 85.8 |
| 033 | CAST IN PLACE CONCRETE | 101.7 | 70.2 | 88.2 | 95.5 | 48.9 | 75.6 | 101.1 | 71.2 | 88.3 | 95.6 | 57.9 | 79.5 | 95.5 | 49.5 | 75.8 | 95.5 | 53.3 | 77.5 |
| 3 | CONCRETE | 92.4 | 70.2 | 81.2 | 89.4 | 57.0 | 73.0 | 94.0 | 72.1 | 82.9 | 90.5 | 62.2 | 76.2 | 89.4 | 57.0 | 73.0 | 89.7 | 65.1 | 77.3 |
| 4 | MASONRY | 82.8 | 66.9 | 72.9 | 83.4 | 38.9 | 55.7 | 92.1 | 63.6 | 74.4 | 92.2 | 49.1 | 65.4 | 83.4 | 39.3 | 56.0 | 98.6 | 46.7 | 66.4 |
| 5 | METALS | 102.2 | 92.4 | 98.5 | 96.8 | 89.0 | 93.9 | 93.7 | 74.5 | 86.4 | 92.4 | 69.4 | 83.7 | 96.7 | 89.3 | 93.9 | 91.7 | 90.1 | 91.1 |
| 6 | WOOD & PLASTICS | 94.5 | 65.2 | 79.8 | 93.7 | 51.6 | 72.6 | 99.7 | 72.2 | 86.0 | 95.9 | 64.6 | 80.3 | 93.7 | 51.3 | 72.5 | 97.4 | 69.9 | 83.6 |
| 7 | THERMAL & MOISTURE PROTECTION | 96.6 | 64.3 | 81.7 | 96.4 | 55.7 | 77.6 | 94.2 | 70.0 | 83.0 | 93.6 | 59.5 | 77.9 | 96.1 | 55.7 | 77.5 | 95.1 | 62.9 | 80.2 |
| 8 | DOORS & WINDOWS | 98.1 | 60.4 | 89.0 | 95.9 | 53.7 | 85.7 | 94.2 | 67.9 | 87.9 | 90.6 | 59.3 | 83.1 | 95.9 | 53.8 | 85.7 | 94.2 | 64.8 | 87.1 |
| 092 | LATH, PLASTER & GYPSUM BOARD | 101.6 | 64.8 | 77.7 | 101.6 | 50.7 | 68.6 | 112.5 | 72.0 | 86.2 | 111.3 | 64.1 | 80.7 | 101.6 | 50.4 | 68.4 | 108.3 | 69.5 | 83.2 |
| 095 | ACOUSTICAL TREATMENT & WOOD FLOORING | 102.4 | 64.8 | 78.1 | 102.4 | 50.7 | 69.0 | 108.7 | 72.0 | 84.9 | 108.7 | 64.1 | 79.8 | 102.4 | 50.4 | 68.7 | 95.9 | 69.5 | 78.8 |
| 096 | FLOORING & CARPET | 113.0 | 67.8 | 102.1 | 113.0 | 40.4 | 95.6 | 87.8 | 75.0 | 84.8 | 86.7 | 51.5 | 78.2 | 113.0 | 41.0 | 95.7 | 87.8 | 47.5 | 78.2 |
| 099 | PAINTING & WALL COVERINGS | 104.2 | 65.4 | 81.6 | 100.9 | 50.4 | 71.5 | 99.0 | 72.1 | 83.4 | 99.0 | 47.9 | 69.3 | 100.9 | 48.3 | 70.3 | 102.4 | 59.0 | 77.2 |
| 9 | FINISHES | 107.7 | 65.3 | 86.1 | 105.8 | 48.1 | 76.4 | 95.1 | 71.5 | 83.1 | 94.4 | 58.6 | 76.1 | 105.7 | 47.8 | 76.2 | 91.5 | 62.0 | 76.5 |
| 10-14 | TOTAL DIV. 10-14 | 100.0 | 76.8 | 95.1 | 100.0 | 69.5 | 93.5 | 100.0 | 75.4 | 94.8 | 100.0 | 71.0 | 93.8 | 100.0 | 69.4 | 93.5 | 100.0 | 73.6 | 94.4 |
| 15 | MECHANICAL | 100.0 | 68.7 | 86.2 | 100.0 | 56.8 | 80.9 | 100.1 | 71.7 | 87.5 | 100.1 | 54.0 | 79.7 | 100.0 | 46.2 | 76.2 | 100.0 | 52.1 | 78.8 |
| 16 | ELECTRICAL | 97.5 | 68.1 | 77.9 | 93.3 | 68.1 | 76.5 | 93.4 | 82.3 | 86.0 | 96.9 | 61.3 | 73.2 | 93.3 | 49.4 | 64.0 | 91.4 | 63.3 | 72.7 |
| 1-16 | WEIGHTED AVERAGE | 99.5 | 71.8 | 86.1 | 97.1 | 60.8 | 79.5 | 96.5 | 75.0 | 86.1 | 95.5 | 62.5 | 79.5 | 97.1 | 55.7 | 77.1 | 95.4 | 65.4 | 80.9 |

| DIVISION | | GEORGIA | | | | | | HAWAII | | | IDAHO | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SAVANNAH | | | VALDOSTA | | | HONOLULU | | | BOISE | | | LEWISTON | | | POCATELLO | | |
| | | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL |
| 2 | SITE WORK | 110.6 | 76.1 | 84.0 | 122.0 | 74.5 | 85.5 | 115.0 | 112.0 | 112.7 | 86.4 | 99.3 | 96.3 | 90.4 | 92.7 | 92.2 | 89.1 | 99.3 | 96.9 |
| 031 | CONCRETE FORMWORK | 97.0 | 60.5 | 66.0 | 80.8 | 51.9 | 56.3 | 102.1 | 158.7 | 150.1 | 97.4 | 89.3 | 90.5 | 106.3 | 87.1 | 90.0 | 97.4 | 89.3 | 90.5 |
| 032 | CONCRETE REINFORCEMENT | 100.7 | 69.5 | 83.2 | 100.8 | 50.3 | 72.5 | 109.9 | 125.0 | 118.4 | 96.0 | 78.4 | 86.1 | 108.6 | 96.1 | 101.6 | 96.3 | 78.5 | 86.3 |
| 033 | CAST IN PLACE CONCRETE | 91.5 | 56.6 | 76.6 | 93.0 | 57.4 | 77.8 | 170.2 | 127.7 | 152.0 | 98.6 | 93.8 | 96.6 | 107.8 | 93.9 | 101.8 | 99.6 | 93.8 | 97.1 |
| 3 | CONCRETE | 88.3 | 62.5 | 75.3 | 92.8 | 55.5 | 74.0 | 153.0 | 139.4 | 146.1 | 103.2 | 88.7 | 95.9 | 115.5 | 91.0 | 103.1 | 103.7 | 88.6 | 96.1 |
| 4 | MASONRY | 86.9 | 57.6 | 68.7 | 89.8 | 50.6 | 65.4 | 131.3 | 134.3 | 133.2 | 131.8 | 81.0 | 100.2 | 128.8 | 96.6 | 108.8 | 136.3 | 82.7 | 103.0 |
| 5 | METALS | 97.1 | 87.6 | 93.5 | 96.5 | 80.7 | 90.6 | 117.4 | 107.6 | 113.7 | 112.9 | 82.2 | 101.3 | 96.2 | 90.7 | 94.1 | 112.5 | 82.2 | 101.1 |
| 6 | WOOD & PLASTICS | 93.8 | 60.9 | 77.3 | 76.0 | 50.3 | 63.1 | 100.6 | 165.6 | 133.1 | 95.1 | 88.5 | 91.8 | 98.7 | 83.6 | 91.2 | 95.1 | 88.5 | 91.8 |
| 7 | THERMAL & MOISTURE PROTECTION | 96.4 | 59.2 | 79.3 | 96.1 | 60.0 | 79.5 | 109.5 | 133.7 | 120.6 | 97.9 | 84.0 | 91.5 | 167.6 | 89.8 | 131.7 | 98.0 | 83.8 | 91.5 |
| 8 | DOORS & WINDOWS | 95.9 | 56.7 | 86.4 | 91.4 | 46.3 | 80.5 | 110.6 | 146.5 | 119.2 | 94.9 | 81.7 | 91.7 | 116.3 | 85.0 | 108.7 | 94.9 | 78.5 | 91.0 |
| 092 | LATH, PLASTER & GYPSUM BOARD | 101.6 | 60.4 | 74.9 | 93.7 | 49.4 | 65.0 | 95.7 | 167.7 | 142.3 | 89.0 | 87.9 | 88.3 | 135.3 | 83.0 | 101.4 | 89.0 | 87.9 | 88.3 |
| 095 | ACOUSTICAL TREATMENT & WOOD FLOORING | 102.4 | 60.4 | 75.2 | 98.0 | 49.4 | 66.5 | 132.8 | 167.7 | 155.4 | 96.2 | 87.9 | 90.8 | 144.9 | 83.0 | 104.8 | 96.2 | 87.9 | 90.8 |
| 096 | FLOORING & CARPET | 113.0 | 60.7 | 100.4 | 105.1 | 48.5 | 91.5 | 127.8 | 128.3 | 127.9 | 97.5 | 74.8 | 92.1 | 135.1 | 97.9 | 126.2 | 97.5 | 74.8 | 92.1 |
| 099 | PAINTING & WALL COVERINGS | 100.9 | 59.9 | 77.0 | 100.9 | 43.7 | 67.6 | 123.8 | 148.0 | 137.9 | 109.4 | 67.9 | 85.2 | 134.4 | 91.3 | 109.3 | 109.4 | 78.2 | 91.3 |
| 9 | FINISHES | 105.8 | 60.5 | 82.8 | 101.9 | 50.0 | 75.5 | 124.5 | 153.9 | 139.5 | 93.2 | 84.6 | 88.8 | 156.4 | 89.0 | 122.1 | 93.2 | 85.8 | 89.4 |
| 10-14 | TOTAL DIV. 10-14 | 100.0 | 71.7 | 94.0 | 100.0 | 70.1 | 93.7 | 100.0 | 129.2 | 106.2 | 100.0 | 86.1 | 97.0 | 100.0 | 100.6 | 100.1 | 100.0 | 86.1 | 97.0 |
| 15 | MECHANICAL | 100.0 | 55.8 | 80.5 | 100.0 | 48.7 | 77.3 | 100.1 | 119.4 | 108.6 | 99.8 | 85.6 | 93.5 | 100.6 | 94.1 | 97.7 | 99.8 | 85.6 | 93.5 |
| 16 | ELECTRICAL | 93.3 | 65.4 | 74.7 | 90.2 | 40.8 | 57.2 | 109.7 | 128.8 | 122.5 | 85.2 | 78.7 | 80.9 | 87.5 | 92.2 | 90.6 | 85.7 | 79.4 | 81.5 |
| 1-16 | WEIGHTED AVERAGE | 97.2 | 64.6 | 81.4 | 96.8 | 55.0 | 76.6 | 115.9 | 129.5 | 122.5 | 101.0 | 85.2 | 93.4 | 111.9 | 92.1 | 102.3 | 101.3 | 85.5 | 93.7 |

A.3.4-16

# ECO NUMBER 5

## REPAIR HTW LEAKS IN THE MECHANICAL EQUIPMENT ROOMS

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-5
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-5 REPAIR HTW LEAKS IN MECHANICAL ROOMS
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 3804. | | |
| B. SIOH | $ 229. | | |
| C. DESIGN COST | $ 229. | | |
| D. TOTAL COST (1A+1B+1C) | $ 4262. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 4262. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 2. | $ 29. | 15.08 | $ 435. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 1612. | $ 2160. | 14.88 | $ 32142. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 1614. | $ 2189. | | $ 32577. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 235.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 3497.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 3497.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 2424.

5. SIMPLE PAYBACK PERIOD (1G/4) 1.76 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 36074.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 8.46
(IF < 1 PROJECT DOES NOT QUALIFY)

WITH ECO's 9A & 12A

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-5X
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-5 REPAIR HTW LEAKS IN MECHANICAL ROOMS
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-15-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 3804. | | |
| B. SIOH | $ 229. | | |
| C. DESIGN COST | $ 229. | | |
| D. TOTAL COST (1A+1B+1C) | $ 4262. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 4262. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 2. | $ 29. | 15.08 | $ 435. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 1393. | $ 1867. | 14.88 | $ 27775. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 1395. | $ 1895. | | $ 28210. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 235.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 3497.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 3497.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 2130.

5. SIMPLE PAYBACK PERIOD (1G/4) 2.00 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 31707.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 7.44
(IF < 1 PROJECT DOES NOT QUALIFY)

WITH ECO'S 9A, 12A & 12B

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-5Y
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-5 REPAIR HTW LEAKS IN MECHANICAL ROOMS
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-15-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 3804. | | |
| B. SIOH | $ 229. | | |
| C. DESIGN COST | $ 229. | | |
| D. TOTAL COST (1A+1B+1C) | $ 4262. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 4262. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 2. | $ 29. | 15.08 | $ 435. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 1232. | $ 1651. | 14.88 | $ 24565. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 1234. | $ 1680. | | $ 25000. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 235.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 3497.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 3497.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 1915.

5. SIMPLE PAYBACK PERIOD (1G/4) 2.23 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 28497.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 6.69
(IF < 1 PROJECT DOES NOT QUALIFY)

RS&H

SUBJECT FORT STEWART
REPAIR MECH. RM. LEAKS
DESIGNER W. TODD
CHECKER

AEP NO 694 131 002
SHEET OF
DATE 2-8-96
DATE

ECO-5 SUMMARY

ANNUAL SAVINGS

HEATING FUELS = 1750 − 138 = $\boxed{1612 \text{ MBTU/YR}}$

ELECTRICITY = 2.3 − 0.2 = $\boxed{2.1 \text{ MBTU/YR}}$

WATER = \$256 − \$20 = $\boxed{\$236\text{/YR}}$

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. | |
| AEP Number: | 694-1331-002 | Designer: | W. T. Todd |
| Project: | Existing Leaks in Mech. Rooms | Date: | 02/08/96 |
| ECO Number: | 5 | | |

Assumptions:

| | | |
|---|---|---|
| 1. HTW temperature | 380 | °F |
| 2. Make-up water temperature | 70 | °F |
| 3. Boiler efficiency | 68% | |
| 4. Pump head (from record drawings) | 300 | Ft H20 |
| 5. Pump efficiency (from record drawings | 72% | |
| 6. Motor efficiency | 90% | |
| 7. Average heating fuel cost | $1.34 | /MBtu |
| 8. Electricity cost | $0.0469 | /kWh |
| 9. Water cost | $0.5562 | /kGallons |

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

459900 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 1189.7 MBtu/Yr

Heating Fuel Use = 1189.7 MBtu/yr / 0.68 = 1749.6 MBtu/Yr

Heating Fuel Cost = 1749.6 MBtu/yr x $1.34 /MBtu = $2,344 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$BHP = \frac{0.88 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.09 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency ) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.09 BHP / 0.90 x 0.746 kW/HP = 0.08 kW

Electricity Use = 0.08 kW x 8760 Hr/Yr = 669 kWh/Yr

Electricity Use = 669 kWh/Yr x 0.003413 MBtu/kWh = 2.3 MBtu/Yr

Electricity Cost = 669 kWh/Yr x $0.0469 /kWh = $31 /Year

Water Cost:

459900 Gal/Yr x $0.5562 /kGal = $256 /Year

Total Utility Cost:

| | | |
|---|---|---|
| Heating Fuel Cost | $2,344 | /Year |
| Pumping (Elec) Cost | $31 | /Year |
| Water Cost | $256 | /Year |
| Total Utility Cost | $2,631 | /Year |

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. | |
| AEP Number: | 694-1331-002 | Designer: | W. T. Todd |
| Project: | Repair Leaks in Mech. Rooms | Date: | 02/08/96 |
| ECO Number: | 5 | | |

Assumptions:

| | | |
|---|---|---|
| 1. HTW temperature | 380 | °F |
| 2. Make-up water temperature | 70 | °F |
| 3. Boiler efficiency | 68% | |
| 4. Pump head (from record drawings) | 300 | Ft H20 |
| 5. Pump efficiency (from record drawings | 72% | |
| 6. Motor efficiency | 90% | |
| 7. Average heating fuel cost | $1.34 | /MBtu |
| 8. Electricity cost | $0.0469 | /kWh |
| 9. Water cost | $0.5562 | /kGallons |

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

36260 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 93.8 MBtu/Yr

Heating Fuel Use = 93.8 MBtu/yr / 0.68 = 137.9 MBtu/Yr

Heating Fuel Cost = 137.9 MBtu/yr x $1.34 /MBtu = $185 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$\text{BHP} = \frac{0.07 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.01 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency ) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.01 BHP / 0.90 x 0.746 kW/HP = 0.01 kW

Electricity Use = 0.01 kW x 8760 Hr/Yr = 53 kWh/Yr

Electricity Use = 53 kWh/Yr x 0.003413 MBtu/kWh = 0.2 MBtu/Yr

Electricity Cost = 53 kWh/Yr x $0.0469 /kWh = $2 /Year

Water Cost:

36260 Gal/Yr x $0.5562 /kGal = $20 /Year

Total Utility Cost:

| | | |
|---|---|---|
| Heating Fuel Cost | $185 | /Year |
| Pumping (Elec) Cost | $2 | /Year |
| Water Cost | $20 | /Year |
| Total Utility Cost | $207 | /Year |

| | | | |
|---|---|---|---|
| **RS&H** | SUBJECT: Fort Stewart<br>Repair Leaks in ME Rooms | AEP NO: 694 1331 002 | |
| | DESIGNER: W. Todd | SHEET: | OF: |
| | CHECKER: | DATE: 2-6-96 | |
| | | DATE: | |

## HTW Losses

The spreadsheet on the following pages lists the leaks found in all of the mechanical rooms. The leaks were measured with a beaker and timed with a stopwatch.

Major Leaks:

There are 8 major leaks totaling 0.737 GPM

$$0.737\ \text{GPM} \times 1440\ \frac{\text{min}}{\text{day}} \times 365\ \frac{\text{day}}{\text{YR}} = 387{,}370\ \text{GAL/YR}$$

Assume all of these leaks can be repaired.

Minor Leaks:

There are 38 minor leaks totaling 0.138 GPM

Assume 50% of the leaks can be repaired.

$$0.138\ \text{GPM} \times 1440\ \frac{\text{min}}{\text{day}} \times 365\ \frac{\text{day}}{\text{YR}} \times 0.5 = 36{,}270\ \text{GAL/YR}$$

$$\text{Current HTW losses} = 0.875\ \text{GPM} \times 1440\ \frac{\text{min}}{\text{day}} \times 365\ \frac{\text{day}}{\text{YR}} = \underline{459900\ \frac{\text{GAL}}{\text{YR}}}$$

$$\text{Savings} = (387{,}370 + 36270)\ \text{GAL/YR} = 423640\ \frac{\text{GAL}}{\text{YR}}$$

$$\text{New HTW losses} = 459{,}900\ \frac{\text{GAL}}{\text{YR}} - 423{,}640\ \frac{\text{GAL}}{\text{YR}} = \underline{36260\ \frac{\text{GAL}}{\text{YR}}}$$

There are 36 leaking valves. Assuming 25% of them will have to be replaced:

$$36\ \text{valves} \times .25 \Rightarrow 9\ \text{valves to be replaced}$$

| Building No. | HTW Zone | Building Type | DHW Temp. | Water Sample | Mech Rm Survey | HTW Leaks | Other Leaks | HTW Drop/Sec | HTW Cup/Min |
|---|---|---|---|---|---|---|---|---|---|
| 206 | 3 | Learning Center | 80 | DHW | Y | Y | Y | 2.00 | 0.33 |
| 207 | 3 | Dining Facility | 124 | DHW | Y | N | N | | |
| 208 | 3 | Fitness Center | 113 | DHW | Y | Y | N | 0.06 | |
| 211 | 3 | Admin. | N/A | N/A | Y | Y | N | 4.00 | |
| 212 | 3 | Admin/Barracks | 131 | DHW | Y | N | N | | |
| 213 | 3 | Barracks | 120 | DHW | Y | N | N | | |
| 215 | 3 | Barracks | 137 | DHW | Y | Y | N | 2.00 | 1.50 |
| 216 | 3 | Barracks | 110 | DHW | Y | Y | N | 2.50 | |
| 217 | 3 | Admin. | N/A | N/A | Y | Y | N | 0.13 | |
| 218 | 3 | Barracks | 124 | DHW | Y | N | Y | | |
| 223 | 3 | Admin. | N/A | N/A | Y | Y | N | 0.17 | |
| 224 | 3 | Admin. | N/A | N/A | Y | Y | N | 5.00 | 6.67 |
| 225 | 3 | Admin. | N/A | N/A | Y | N | N | | |
| 230 | 3 | Tac Equip Shop | N/A | N/A | Y | N | N | | |
| 241 | 3 | Tac Equip Shop | N/A | N/A | Y | N | N | | |
| 260 | 3 | Tac Equip Shop | N/A | N/A | Y | N | N | | |
| 270 | 3 | Tac Equip Shop | N/A | N/A | Y | Y | N | 2.20 | |
| 276 | 3 | Tac Equip Shop | N/A | N/A | N | | | | |
| 302 | 3 | Hospital | 137 | DHW | Y | N | N | | |
| 403 | N/A | Child Care Ctr | N/A | N/A | Y | N/A | N | | |
| 439 | N/A | Fitness Center | 139 | DHW | Y | N/A | N | | |
| 440 | 2 | Dental Clinic | 114 | DHW | Y | N | N | | |
| 501 | 2 | Barracks | 134 | DHW | Y | Y | N | 0.33 | |
| 503 | 2 | Barracks | 122 | DHW | Y | Y | N | 2.00 | 0.25 |
| 504 | 2 | Barracks | 158 | DHW | Y | Y | N | | 0.75 |
| 506 | 2 | Admin. | N/A | N/A | Y | N | N | | |
| 507 | 2 | Admin. | N/A | N/A | Y | Y | N | 1.00 | |
| 508 | 2 | Admin. | N/A | N/A | Y | N | N | | |
| 509 | 2 | Admin. | N/A | N/A | Y | N | Y | | |
| 512 | 2 | Dining Facility | 145 | DHW | Y | ? | Y | | 1.17 |
| 514 | 2 | Barracks | 126 | DHW | Y | Y | N | 1.25 | |
| 515 | 2 | Barracks | 123 | DHW | Y | N | Y | | |
| 516 | 2 | Barracks | 145 | DHW | Y | ? | Y | | |
| 517 | 2 | Barracks | 175 | DHW | LOCKED | | | | |
| 518 | 2 | Barracks | 183 | DHW | Y | ? | Y | 3.33 | |
| 520 | 2 | Admin. | N/A | N/A | Y | N | Y | | |
| 521 | 2 | Admin. | N/A | N/A | Y | Y | N | 0.50 | |
| 522 | 2 | Admin. | N/A | N/A | Y | Y | N | 0.25 | |
| 523 | 2 | Admin. | N/A | N/A | Y | N | N | | |
| 524 | 2 | Admin. | N/A | N/A | Y | N | N | | |
| 525 | 2 | Admin. | N/A | N/A | Y | Y | N | 0.09 | |

| Building No. | HTW Zone | Building Type | DHW Temp. | Water Sample | Mech Rm Survey | HTW Leaks | Other Leaks | HTW Drop/Sec | HTW Cup/Min |
|---|---|---|---|---|---|---|---|---|---|
| 608 | 2 | Fitness Center | 127 | DHW | Y | Y | N | 0.08 | |
| 610 | 2 | Chapel | 115 | DHW | Y | N | N | | |
| 612 | 2 | Admin. | N/A | N/A | Y | Y | Y | 0.08 | |
| 614 | 1 | Admin. | N/A | N/A | Y | N | Y | | |
| 616 | 1 | Admin. | N/A | N/A | Y | N | Y | | |
| 617 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 618 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 619 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 620 | 1 | Admin. | 112 | DHW | Y | N | N | | |
| 621 | 1 | Admin. | 91 | DHW | Y | N | N | | |
| 622 | 1 | Admin. | 85 | DHW | Y | N | N | | |
| 623 | 1 | Admin. | 109 | DHW | Y | N | Y | | |
| 624 | 1 | Admin. | 109 | DHW | Y | N | Y | | |
| 626 | 1 | Dining Facility | 145 | DHW | Y | N | N | | |
| 628 | 1 | Admin. | N/A | N/A | Y | Y | N | 0.20 | |
| 629 | 1 | Barracks | 160 | DHW | Y | ? | Y | | |
| 630 | 1 | Barracks | 117 | DHW | Y | N | Y | | |
| 631 | 1 | Barracks | 142 | DHW | Y | Y | Y | | 0.88 |
| 632 | 1 | Barracks | 160 | DHW | Y | N | Y | | |
| 633 | 1 | Barracks | 128 | DHW | Y | Y | Y | 2.00 | |
| 634 | 1 | Barracks | LOCKED | LOCKED | Y | N | N | | |
| 635 | 1 | Barracks | 140 | DHW | Y | Y | N | 1.59 | |
| 636 | 1 | Barracks | 138 | DHW | Y | Y | Y | 1.22 | |
| 637 | 1 | Barracks | 158 | DHW | Y | N | N | | |
| 638 | 1 | Admin. | N/A | N/A | Y | N | Y | | |
| 639 | 1 | Admin. | N/A | N/A | Y | Y | N | 1.56 | |
| 640 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 641 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 642 | 1 | Dining Facility | 154 | DHW | Y | N | Y | | |
| 643 | 1 | Admin. | N/A | N/A | Y | Y | N | 0.10 | |
| 644 | 1 | Admin. | N/A | N/A | Y | Y | N | 0.33 | |
| 645 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 646 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 647 | 1 | Admin. | N/A | N/A | Y | Y | N | 0.20 | |
| 648 | 1 | Admin. | N/A | N/A | Y | N | Y | | |
| 649 | 1 | Admin. | N/A | N/A | Y | N | N | | |

Fort Stewart - HTW Distribution System Filename: FS-BLDGS.WB2

| Building No. | HTW Zone | Building Type | DHW Temp. | Water Sample | Mech Rm Survey | HTW Leaks | Other Leaks | HTW Drop/Sec | HTW Cup/Min |
|---|---|---|---|---|---|---|---|---|---|
| 701 | 1 | Health Clinic | 152 | DHW | Y | Y | N | 1.00 | |
| 702 | 1 | Ent. Center | 143 | DHW | Y | N | N | | |
| 703 | 1 | Enl. Mens Club | N/A | N/A | LOCKED | | Y | | |
| 704 | 1 | Theater | N/A | N/A | Y | N | Y | | |
| 706 | 1 | Branch Exchange | N/A | N/A | Y | N | Y | | |
| 708 | 1 | Fitness Center | 131 | DHW | Y | N | Y | | |
| 710 | 1 | Admin. | N/A | N/A | Y | N | Y | | |
| 712 | 1 | Barracks | 135 | DHW | Y | N | Y | | |
| 713 | 1 | Barracks | 133 | DHW | Y | N | Y | | |
| 714 | 1 | Barracks | 137 | DHW | Y | N | Y | | |
| 715 | 1 | Barracks | 135 | DHW | Y | Y | N | 0.20 | |
| 717 | 1 | Barracks | 131 | DHW | Y | N | N | | |
| 718 | 1 | Barracks | 124 | DHW | Y | Y | Y | 0.20 | |
| 719 | 1 | Barracks | 112 | DHW | Y | Y | N | 1.00 | |
| 720 | 1 | Barracks | 130 | DHW | Y | N | Y | | |
| 721 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 722 | 1 | Admin. | N/A | N/A | Y | Y | Y | 5.00 | |
| 723 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 724 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 725 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 726 | 1 | Dining Facility | 158 | DHW | Y | N | Y | | |
| 727 | N/A | Training Facility | N/A | N/A | Y | N/A | N | | |
| 728 | 1 | Admin. | N/A | N/A | Y | Y | N | 3.05 | |
| 810 | 1 | Barracks | 131 | DHW | Y | N | N | | |
| 811 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 812 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 813 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 814 | 1 | Admin. | N/A | N/A | Y | N | Y | | |
| 815 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 816 | 1 | Admin. | N/A | N/A | Y | N | Y | | |
| 818 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 819 | 1 | Admin. | N/A | N/A | Y | Y | N | 0.13 | |

Fort Stewart - HTW Distribution System    Filename: FS-BLDGS.WB2

| Building No. | HTW Zone | Building Type | DHW Temp. | Water Sample | Mech Rm Survey | HTW Leaks | Other Leaks | HTW Drop/Sec | HTW Cup/Min |
|---|---|---|---|---|---|---|---|---|---|
| 1160 | 3 | D.S. Maint Fac | N/A | N/A | Y | Y | N | 2.03 | |
| 1170 | 3 | G.S. Maint Fac | N/A | N/A | Y | N | N | | |
| 1208 | 1 | Tac Equip Shop | N/A | N/A | Y | N | Y | | |
| 1209 | 1 | Tac Equip Shop | N/A | N/A | Y | N | N | | |
| 1211 | 1 | Tac Equip Shop | N/A | N/A | Y | N | N | | |
| 1245 | N/A | Tac Equip Shop | N/A | N/A | Y | N/A | Y | | |
| 1259 | 1 | Tac Equip Shop | N/A | N/A | Y | Y | N | | 0.25 |
| 1261 | 2 | Tac Equip Shop | N/A | N/A | N | | | | |
| 1265 | 2 | Tac Equip Shop | N/A | N/A | Y | N | N | | |
| 1280 | N/A | Tac Equip Shop | N/A | N/A | Y | N/A | Y | | |
| 1320 | 2 | Tac Equip Shop | N/A | N/A | Y | N | N | | |
| 1330 | 2 | Tac Equip Shop | N/A | N/A | Y | Y | N | 0.13 | |
| 1340 | 2 | Tac Equip Shop | N/A | N/A | Y | N | N | | |
| 1412 | | C. Energy Plant | N/A | HTW | Y | Y | | | |
| 1500 | 3 | Div Logis Fac | N/A | N/A | w/ 1509? | | | | |
| 1503 | 3 | Auto Hobby Shop | N/A | N/A | LOCKED | | | | |
| 1509 | 3 | Div Logis Fac | N/A | N/A | Y | Y | Y | 3.00 | |
| 1510 | 3 | Tac Equip Shop | N/A | N/A | N | | | | |
| 1540 | 3 | Tac Equip Shop | 95 | PW | N | | | | |
| 1720 | 2 | D.S. Maint Fac | 148 | DHW | Y | N-N/A | N | | |
| 1810 | 2 | Tac Equip Shop | N/A | N/A | N | | | | |
| 1820 | 2 | Tac Equip Shop | N/A | N/A | Y | N-N/A | N | | |
| 1840 | 2 | Tac Equip Shop | N/A | N/A | Y | N | Y | | |
| 2115 | 1 | Dental Clinic | N/A | N/A | Y | N | N | | |
| 2125 | 1 | Chapel | 120 | DHW | Y | N | N | | |
| 3001 | S | S. Energy Plant | N/A | N/A | Y | Y | | | |
| 3002 | S | Admin. | N/A | N/A | Y | Y | N | 5.20 | |
| 4502 | S | Tac Equip Shop | N/A | N/A | N | | | | |
| 4528 | S | Tac Equip Shop | N/A | N/A | N | | | | |
| 4577 | S | Tac Equip Shop | N/A | N/A | N | | | | |
| 4578 | S | Tac Equip Shop | N/A | N/A | N | | | | |
| TOTALS | | 140 | | | 127 | 42 | 41 | 55.11 Drop/Sec | 11.80 Cup/Min |

| | | |
|---|---|---|
| Leaks (GPM) = | 0.138 | 0.737 |
| % of Total = | 16% | 84% |
| Total Leaks = | 0.875 GPM | |

# CONSTRUCTION COST ESTIMATE

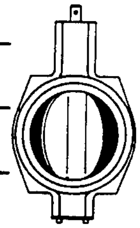
| | | | |
|---|---|---|---|
| Project: | Repair HTW Leaks in Mechanical Rooms | RS&H No.: | 694-1331-002 |
| Location: | Fort Stewart, GA | Date: | 02/14/96 |
| Basis: | Schematic Design | Estimator: | W.T.Todd |
| ECO No.: | 5 | Filename: | EST-5.WQ1 |

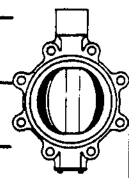
| ITEM DESCRIPTION | QUANTITY | | MATERIAL/EQUIP | | LABOR | | TOTAL COST | SOURCE | |
|---|---|---|---|---|---|---|---|---|---|
| | No. | Unit | $/Unit | Total | $/Unit | Total | | Material | Labor |
| Travel time to bldgs. | 7.0 | hr | | 0 | 30.3 | 212 | 212 | | (1) |
| Repair/tighten valves | 4.5 | hr | | 0 | 30.3 | 136 | 136 | | (2) |
| Repair/tighten flanges | 2.3 | hr | | 0 | 30.3 | 71 | 71 | | (3) |
| Remove valves (4) | 9 | Ea | | 0 | 52.8 | 475 | 475 | | MMp191 |
| 2" gate valve, 250 lb (4) | 9 | Ea | 256 | 2304 | 52.8 | 475 | 2,779 | MMp191 | MMp191 |
| Subtotal Bare Costs | | | | 2304 | | 1369 | $3,673 | | |
| Retrofit Cost Factors | | | 0% | 0 | 0% | 0 | 0 | MMp6 | MMp6 |
| Subtotal | | | | 2304 | | 1369 | 3,673 | | |
| City Cost Index (Sav. GA) | | | 0% | 0 | -44% | -605 | (605) | MMp533 | MMp533 |
| Subtotal | | | | 2304 | | 764 | 3,068 | | |
| OH & Profit Markups | | | 10% | 230 | 53% | 405 | 635 | MMp7 | MMp475 |
| Subtotal | | | | 2534 | | 1169 | 3,703 | | |
| Sales Taxes | | | 4.0% | 101 | | NA | 101 | MMp476 | |
| Total Construction Cost | | | | 2635 | | 1169 | 3,804 | | |
| Design Fee | | | | NA | 6.0% | 228 | 228 | | |
| SIOH | | | | NA | 6.0% | 228 | 228 | | |
| Subtotal | | | | 2635 | | 1625 | 4,260 | | |
| Contingency | | | 0% | 0 | 0% | 0 | 0 | MEp6 | MEp6 |
| Total Project Cost | | | | 2635 | | 1625 | $4,260 | | |

LEGEND:
- (1) Estimate 10 minutes per building for 42 buildings.
- (2) Estimate 10 minutes per valve for 27 valves (also see note 4).
- (3) Estimate 10 minutes per flange for 14 flanges.
- (4) Assumes 25 % of the 36 leaking valves will be replaced.
- MMp### 1996 Means Mechanical Cost Data, page ###.

## 151 950 | Valves

| | | | CREW | DAILY OUTPUT | LABOR-HOURS | UNIT | 1996 BARE COSTS MAT. | LABOR | EQUIP. | TOTAL | TOTAL INCL O&P |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 960 | 1050 | 3" size (R151-090) | Q-1 | 8 | 2 | Ea. | 175 | 54 | | 229 | 276 960 |
| | 1060 | 4" size | | 5 | 3.200 | | 215 | 86.50 | | 301.50 | 370 |
| | 1070 | 5" size | Q-2 | 5 | 4.800 | | 250 | 135 | | 385 | 480 |
| | 1080 | 6" size | | 5 | 4.800 | | 273 | 135 | | 408 | 505 |
| | 1090 | 8" size | | 4.50 | 5.333 | | 360 | 150 | | 510 | 625 |
| | 1100 | 10" size | | 4 | 6 | | 415 | 168 | | 583 | 715 |
| | 1110 | 12" size | | 3 | 8 | | 570 | 224 | | 794 | 970 |
| | 1200 | Lug type, lever actuator | | | | | | | | | |
| | 1220 | 2" size | 1 Plum | 14 | .571 | Ea. | 87 | 17.15 | | 104.15 | 122 |
| | 1230 | 2-1/2" size | Q-1 | 9 | 1.778 | | 89 | 48 | | 137 | 172 |
| | 1240 | 3" size | | 8 | 2 | | 95 | 54 | | 149 | 188 |
| | 1250 | 4" size | | 5 | 3.200 | | 121 | 86.50 | | 207.50 | 265 |
| | 1260 | 5" size | Q-2 | 5 | 4.800 | | 175 | 135 | | 310 | 400 |
| | 1270 | 6" size | | 5 | 4.800 | | 197 | 135 | | 332 | 425 |
| | 1280 | 8" size | | 4.50 | 5.333 | | 281 | 150 | | 431 | 540 |
| | 1290 | 10" size | | 4 | 6 | | 390 | 168 | | 558 | 690 |
| | 1300 | 12" size | | 3 | 8 | | 595 | 224 | | 819 | 1,000 |
| | 1320 | For gear actuator, add | | | | | 60% | | | | |
| | 1400 | Diverter, 150 lb. flanged, bronze or iron plugs | | | | | | | | | |
| | 1440 | 2" pipe size | Q-1 | 2 | 8 | Ea. | 2,475 | 216 | | 2,691 | 3,050 |
| | 1450 | 3" pipe size | " | 1.50 | 10.667 | " | 3,550 | 289 | | 3,839 | 4,350 |
| | 1650 | Gate, 125 lb., N.R.S., | | | | | | | | | |
| | 2150 | Flanged | | | | | | | | | |
| | 2200 | 2" size | 1 Plum | 5 | 1.600 | Ea. | 252 | 48 | | 300 | 350 |
| | 2240 | 2-1/2" size | Q-1 | 5 | 3.200 | | 258 | 86.50 | | 344.50 | 415 |
| | 2260 | 3" size | | 4.50 | 3.556 | | 290 | 96 | | 386 | 465 |
| | 2280 | 4" size | | 3 | 5.333 | | 415 | 144 | | 559 | 675 |
| | 2290 | 5" size | Q-2 | 3.40 | 7.059 | | 705 | 198 | | 903 | 1,075 |
| | 2300 | 6" size | | 3 | 8 | | 705 | 224 | | 929 | 1,125 |
| | 2320 | 8" size | | 2.50 | 9.600 | | 1,225 | 269 | | 1,494 | 1,750 |
| | 2340 | 10" size | | 2.20 | 10.909 | | 2,150 | 305 | | 2,455 | 2,850 |
| | 2360 | 12" size | | 1.70 | 14.118 | | 2,950 | 395 | | 3,345 | 3,850 |
| | 2370 | 14" size | | 1.30 | 18.462 | | 3,575 | 520 | | 4,095 | 4,725 |
| | 2380 | 16" size | | 1 | 24 | | 5,225 | 675 | | 5,900 | 6,775 |
| | 2420 | For 250 lb., flanged, add | | | | | 200% | 10% | | | |
| | 3550 | OS&Y, flanged | | | | | | | | | |
| | 3600 | 2" size | 1 Plum | 5 | 1.600 | Ea. | 128 | 48 | | 176 | 215 |
| | 3640 | 2-1/2" size | Q-1 | 5 | 3.200 | | 132 | 86.50 | | 218.50 | 277 |
| | 3660 | 3" size | | 4.50 | 3.556 | | 149 | 96 | | 245 | 310 |
| | 3670 | 3-1/2" size | | 3 | 5.333 | | 212 | 144 | | 356 | 455 |
| | 3680 | 4" size | | 3 | 5.333 | | 212 | 144 | | 356 | 455 |
| | 3690 | 5" size | Q-2 | 3.40 | 7.059 | | 350 | 198 | | 548 | 690 |
| | 3700 | 6" size | | 3 | 8 | | 350 | 224 | | 574 | 730 |
| | 3720 | 8" size | | 2.50 | 9.600 | | 625 | 269 | | 894 | 1,100 |
| | 3740 | 10" size | | 2.20 | 10.909 | | 1,150 | 305 | | 1,455 | 1,750 |
| | 3760 | 12" size | | 1.70 | 14.118 | | 1,525 | 395 | | 1,920 | 2,275 |
| | 3770 | 14" size | | 1.30 | 18.462 | | 2,950 | 520 | | 3,470 | 4,050 |
| | 3780 | 16" size | | 1 | 24 | | 4,575 | 675 | | 5,250 | 6,050 |
| | 3790 | 18" size | | .80 | 30 | | 6,125 | 840 | | 6,965 | 8,050 |
| | 3800 | 20" size | | .60 | 40 | | 8,550 | 1,125 | | 9,675 | 11,100 |
| | 3830 | 24" size | | .50 | 48 | | 12,700 | 1,350 | | 14,050 | 16,100 |
| | 3900 | For 250 lb flanged, add | | | | | 200% | 10% | | | |
| | 4350 | Globe, OS&Y, | | | | | | | | | |
| | 4540 | Class 125, flanged | | | | | | | | | |
| | 4550 | 2" size | 1 Plum | 5 | 1.600 | Ea. | 266 | 48 | | 314 | 365 |
| | 4560 | 2-1/2" size | Q-1 | 5 | 3.200 | | 281 | 86.50 | | 367.50 | 440 |





MECHANICAL 15

A.3.5-14

## Installing Contractor's Overhead & Profit

Below are the **average** installing contractor's percentage mark-ups applied to base labor rates to arrive at typical billing rates.

**Column A:** Labor rates are based on union wages averaged for 30 major U.S. cities. Base rates including fringe benefits are listed hourly and daily. These figures are the sum of the wage rate and employer-paid fringe benefits such as vacation pay, employer-paid health and welfare costs, pension costs, plus appropriate training and industry advancement funds costs.

**Column B:** Workers' Compensation rates are the national average of state rates established for each trade.

**Column C:** Column C lists average fixed overhead figures for all trades. Included are Federal and State Unemployment costs set at 7.3%; Social Security Taxes (FICA) set at 7.65%; Builder's Risk Insurance costs set at 0.34%; and Public Liability costs set at 1.55%. All the percentages except those for Social Security Taxes vary from state to state as well as from company to company.

**Columns D and E:** Percentages in Columns D and E are based on the presumption that the installing contractor has annual billing of $500,000 and up. Overhead percentages may increase with smaller annual billing. The overhead percentages for any given contractor may vary greatly and depend on a number of factors, such as the contractor's annual volume, engineering and logistical support costs, and staff requirements. The figures for overhead and profit will also vary depending on the type of job, the job location, and the prevailing economic conditions. All factors should be examined very carefully for each job.

**Column F:** Column F lists the total of Columns B, C, D, and E.

**Column G:** Column G is Column A (hourly base labor rate) multiplied by the percentage in Column F (O&P percentage).

**Column H:** Column H is the total of Column A (hourly base labor rate) plus Column G (Total O&P).

**Column I:** Column I is Column H multiplied by eight hours.

| | | A | | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Base Rate Incl. Fringes | | Work-ers' Comp. Ins. | Average Fixed Over-head | Over-head | Profit | Total Overhead & Profit | | Rate with O & P | |
| Abbr. | Trade | Hourly | Daily | | | | | % | Amount | Hourly | Daily |
| Skwk | Skilled Workers Average (35 trades) | $25.95 | $207.60 | 20.2% | 16.8% | 13.0% | 10% | 60.0% | $15.55 | $41.50 | $332.00 |
| | Helpers Average (5 trades) | 19.25 | 154.00 | 21.4 | | 11.0 | | 59.2 | 11.40 | 30.65 | 245.20 |
| | Foreman Average, Inside ($.50 over trade) | 26.45 | 211.60 | 20.2 | | 13.0 | | 60.0 | 15.85 | 42.30 | 338.40 |
| | Foreman Average, Outside ($2.00 over trade) | 27.95 | 223.60 | 20.2 | | 13.0 | | 60.0 | 16.75 | 44.70 | 357.60 |
| Clab | Common Building Laborers | 19.80 | 158.40 | 21.9 | | 11.0 | | 59.7 | 11.80 | 31.60 | 252.80 |
| Asbe | Asbestos Workers | 28.55 | 228.40 | 19.7 | | 16.0 | | 62.5 | 17.85 | 46.40 | 371.20 |
| Boil | Boilermakers | 30.05 | 240.40 | 17.7 | | 16.0 | | 60.5 | 18.20 | 48.25 | 386.00 |
| Bric | Bricklayers | 25.90 | 207.20 | 19.4 | | 11.0 | | 57.2 | 14.80 | 40.70 | 325.60 |
| Brhe | Bricklayer Helpers | 20.00 | 160.00 | 19.4 | | 11.0 | | 57.2 | 11.45 | 31.45 | 251.60 |
| Carp | Carpenters | 25.20 | 201.60 | 21.9 | | 11.0 | | 59.7 | 15.05 | 40.25 | 322.00 |
| Cefi | Cement Finishers | 24.35 | 194.80 | 12.8 | | 11.0 | | 50.6 | 12.30 | 36.65 | 293.20 |
| Elec | Electricians | 29.30 | 234.40 | 8.0 | | 16.0 | | 50.8 | 14.90 | 44.20 | 353.60 |
| Elev | Elevator Constructors | 30.05 | 240.40 | 9.6 | | 16.0 | | 52.4 | 15.75 | 45.80 | 366.40 |
| Eqhv | Equipment Operators, Crane or Shovel | 26.75 | 214.00 | 12.9 | | 14.0 | | 53.7 | 14.35 | 41.10 | 328.80 |
| Eqmd | Equipment Operators, Medium Equipment | 25.70 | 205.60 | 12.9 | | 14.0 | | 53.7 | 13.80 | 39.50 | 316.00 |
| Eqlt | Equipment Operators, Light Equipment | 24.70 | 197.60 | 12.9 | | 14.0 | | 53.7 | 13.25 | 37.95 | 303.60 |
| Eqol | Equipment Operators, Oilers | 21.90 | 175.20 | 12.9 | | 14.0 | | 53.7 | 11.75 | 33.65 | 269.20 |
| Eqmm | Equipment Operators, Master Mechanics | 27.55 | 220.40 | 12.9 | | 14.0 | | 53.7 | 14.80 | 42.35 | 338.80 |
| Glaz | Glaziers | 24.90 | 199.20 | 16.0 | | 11.0 | | 53.8 | 13.40 | 38.30 | 306.40 |
| Lath | Lathers | 24.95 | 199.60 | 13.5 | | 11.0 | | 51.3 | 12.80 | 37.75 | 302.00 |
| Marb | Marble Setters | 25.65 | 205.20 | 19.4 | | 11.0 | | 57.2 | 14.65 | 40.30 | 322.40 |
| Mill | Millwrights | 26.55 | 212.40 | 13.2 | | 11.0 | | 51.0 | 13.55 | 40.10 | 320.80 |
| Mstz | Mosaic & Terrazzo Workers | 25.25 | 202.00 | 11.0 | | 11.0 | | 48.8 | 12.30 | 37.55 | 300.40 |
| Pord | Painters, Ordinary | 22.95 | 183.60 | 16.8 | | 11.0 | | 54.6 | 12.55 | 35.50 | 284.00 |
| Psst | Painters, Structural Steel | 23.95 | 191.60 | 62.5 | | 11.0 | | 100.3 | 24.00 | 47.95 | 383.60 |
| Pape | Paper Hangers | 23.30 | 186.40 | 16.8 | | 11.0 | | 54.6 | 12.70 | 36.00 | 288.00 |
| Pile | Pile Drivers | 25.35 | 202.80 | 33.6 | | 16.0 | | 76.4 | 19.35 | 44.70 | 357.60 |
| Plas | Plasterers | 24.20 | 193.60 | 17.4 | | 11.0 | | 55.2 | 13.35 | 37.55 | 300.40 |
| Plah | Plasterer Helpers | 20.15 | 161.20 | 17.4 | | 11.0 | | 55.2 | 11.10 | 31.25 | 250.00 |
| Plum | Plumbers | 30.05 | 240.40 | 10.2 | | 16.0 | | 53.0 | 15.95 | 46.00 | 368.00 |
| Rodm | Rodmen (Reinforcing) | 27.75 | 222.00 | 36.3 | | 14.0 | | 77.1 | 21.40 | 49.15 | 393.20 |
| Rofc | Roofers, Composition | 22.55 | 180.40 | 37.4 | | 11.0 | | 75.2 | 16.95 | 39.50 | 316.00 |
| Rots | Roofers, Tile & Slate | 22.60 | 180.80 | 37.4 | | 11.0 | | 75.2 | 17.00 | 39.60 | 316.80 |
| Rohe | Roofers, Helpers (Composition) | 15.95 | 127.60 | 37.4 | | 11.0 | | 75.2 | 12.00 | 27.95 | 223.60 |
| Shee | Sheet Metal Workers | 28.95 | 231.60 | 13.8 | | 16.0 | | 56.6 | 16.40 | 45.35 | 362.80 |
| Spri | Sprinkler Installers | 31.30 | 250.40 | 10.4 | | 16.0 | | 53.2 | 16.65 | 47.95 | 383.60 |
| Stpi | Steamfitters or Pipefitters | 30.30 | 242.40 | 10.2 | | 16.0 | | 53.0 | 16.05 | 46.35 | 370.80 |
| Ston | Stone Masons | 25.90 | 207.20 | 19.4 | | 11.0 | | 57.2 | 14.80 | 40.70 | 325.60 |
| Sswk | Structural Steel Workers | 27.85 | 222.80 | 46.4 | | 14.0 | | 87.2 | 24.30 | 52.15 | 417.20 |
| Tilf | Tile Layers | 25.05 | 200.40 | 11.0 | | 11.0 | | 48.8 | 12.20 | 37.25 | 298.00 |
| Tilh | Tile Layers Helpers | 20.30 | 162.40 | 11.0 | | 11.0 | | 48.8 | 9.90 | 30.20 | 241.60 |
| Trlt | Truck Drivers, Light | 20.35 | 162.80 | 17.0 | | 11.0 | | 54.8 | 11.15 | 31.50 | 252.00 |
| Trhv | Truck Drivers, Heavy | 20.70 | 165.60 | 17.0 | | 11.0 | | 54.8 | 11.35 | 32.05 | 256.40 |
| Sswl | Welders, Structural Steel | 27.85 | 222.80 | 46.4 | | 14.0 | | 87.2 | 24.30 | 52.15 | 417.20 |
| Wrck | *Wrecking | 19.80 | 158.40 | 44.8 | | 11.0 | | 82.6 | 16.35 | 36.15 | 289.20 |

*Not included in Averages.

| DIVISION | | FLORIDA | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MIAMI | | | ORLANDO | | | PANAMA CITY | | | PENSACOLA | | | ST. PETERSBURG | | | TALLAHASSEE | | |
| | | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL |
| | **SITE WORK** | 110.3 | 72.8 | 81.5 | 125.3 | 85.9 | 95.0 | 141.6 | 83.4 | 96.9 | 138.9 | 85.9 | 98.1 | 126.2 | 85.6 | 95.0 | 125.7 | 85.2 | 94.6 |
| 031 | CONCRETE FORMWORK | 94.2 | 71.0 | 74.5 | 97.3 | 71.6 | 75.5 | 95.8 | 37.8 | 46.6 | 84.5 | 69.7 | 72.0 | 94.1 | 64.8 | 69.3 | 97.3 | 53.0 | 59.7 |
| 032 | CONCRETE REINFORCEMENT | 95.1 | 72.5 | 82.4 | 95.1 | 79.0 | 86.0 | 99.3 | 64.5 | 79.7 | 101.5 | 64.9 | 81.0 | 98.5 | 74.3 | 84.9 | 95.1 | 65.2 | 78.3 |
| 033 | CAST IN PLACE CONCRETE | 91.5 | 75.4 | 84.6 | 88.7 | 78.0 | 84.1 | 95.2 | 43.0 | 72.9 | 95.2 | 69.0 | 84.0 | 101.4 | 70.2 | 88.1 | 91.7 | 58.4 | 77.5 |
| **3** | **CONCRETE** | 87.4 | 74.3 | 80.8 | 86.3 | 76.7 | 81.4 | 95.0 | 46.6 | 70.5 | 93.5 | 70.1 | 81.7 | 92.6 | 70.1 | 81.2 | 87.7 | 59.2 | 73.3 |
| **4** | **MASONRY** | 76.9 | 70.2 | 72.8 | 77.4 | 75.6 | 76.2 | 84.9 | 37.4 | 55.4 | 82.6 | 67.6 | 73.3 | 119.2 | 66.9 | 86.7 | 83.6 | 52.6 | 64.4 |
| **5** | **METALS** | 98.8 | 93.5 | 96.8 | 107.9 | 95.0 | 103.0 | 97.2 | 75.1 | 88.9 | 97.1 | 89.6 | 94.3 | 101.0 | 92.4 | 97.7 | 99.2 | 88.1 | 95.0 |
| **6** | **WOOD & PLASTICS** | 88.6 | 72.7 | 80.6 | 94.5 | 71.1 | 82.8 | 92.9 | 38.3 | 65.6 | 80.1 | 71.1 | 75.6 | 90.8 | 65.2 | 78.0 | 94.5 | 51.6 | 73.0 |
| **7** | **THERMAL & MOISTURE PROTECTION** | 99.6 | 74.6 | 88.0 | 96.6 | 75.6 | 86.9 | 96.9 | 38.3 | 69.9 | 96.6 | 66.9 | 82.9 | 96.3 | 63.1 | 81.0 | 96.6 | 58.8 | 79.1 |
| **8** | **DOORS & WINDOWS** | 95.9 | 69.5 | 89.5 | 98.1 | 68.2 | 90.9 | 95.7 | 35.2 | 81.2 | 95.7 | 66.5 | 88.7 | 96.8 | 60.4 | 88.0 | 98.1 | 53.9 | 87.4 |
| 092 | LATH, PLASTER & GYPSUM BOARD | 101.0 | 72.5 | 82.5 | 101.6 | 70.8 | 81.7 | 99.7 | 36.9 | 59.0 | 94.5 | 70.9 | 79.2 | 98.9 | 64.8 | 76.8 | 101.6 | 50.7 | 68.6 |
| 095 | ACOUSTICAL TREATMENT & WOOD FLOORING | 102.4 | 72.5 | 83.0 | 102.4 | 70.8 | 82.0 | 96.6 | 36.9 | 58.0 | 96.6 | 70.9 | 79.9 | 98.0 | 64.8 | 76.5 | 102.4 | 50.7 | 68.9 |
| 096 | FLOORING & CARPET | 121.8 | 75.3 | 110.7 | 113.0 | 74.9 | 103.8 | 112.3 | 24.6 | 91.3 | 106.7 | 68.0 | 97.4 | 111.4 | 67.8 | 100.9 | 113.0 | 49.7 | 97.8 |
| 099 | PAINTING & WALL COVERINGS | 100.9 | 70.1 | 83.0 | 104.2 | 77.6 | 88.7 | 104.2 | 34.5 | 63.7 | 104.2 | 78.5 | 89.3 | 104.2 | 65.4 | 81.6 | 104.2 | 55.7 | 76.0 |
| **9** | **FINISHES** | 108.6 | 71.4 | 89.7 | 107.7 | 72.7 | 89.9 | 107.2 | 34.4 | 70.2 | 104.5 | 70.5 | 87.2 | 106.0 | 65.3 | 85.3 | 107.7 | 51.9 | 79.3 |
| **10-14** | **TOTAL DIV. 10-14** | 100.0 | 81.8 | 96.1 | 100.0 | 83.9 | 96.6 | 100.0 | 65.4 | 92.6 | 100.0 | 73.3 | 94.3 | 100.0 | 76.8 | 95.1 | 100.0 | 74.0 | 94.5 |
| **15** | **MECHANICAL** | 100.0 | 72.9 | 88.0 | 100.0 | 70.8 | 87.1 | 100.0 | 34.6 | 71.1 | 100.0 | 68.8 | 86.2 | 100.0 | 68.7 | 86.2 | 100.0 | 54.8 | 80.0 |
| **16** | **ELECTRICAL** | 98.0 | 84.9 | 89.3 | 98.0 | 63.0 | 74.6 | 96.3 | 47.1 | 63.5 | 101.8 | 63.4 | 76.2 | 98.5 | 68.1 | 78.2 | 98.0 | 58.3 | 71.5 |
| **1-16** | **WEIGHTED AVERAGE** | 97.5 | 76.7 | 87.4 | 99.2 | 75.1 | 87.6 | 99.2 | 48.1 | 74.5 | 98.8 | 71.8 | 85.7 | 101.0 | 71.8 | 86.9 | 98.5 | 62.1 | 80.9 |

| DIVISION | | FLORIDA | | | GEORGIA | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | TAMPA | | | ALBANY | | | ATLANTA | | | AUGUSTA | | | COLUMBUS | | | MACON | | |
| | | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL |
| **2** | **SITE WORK** | 126.9 | 85.6 | 95.1 | 110.4 | 74.2 | 82.5 | 114.3 | 92.8 | 97.8 | 110.2 | 91.5 | 95.8 | 110.4 | 74.3 | 82.6 | 111.6 | 91.9 | 96.5 |
| 031 | CONCRETE FORMWORK | 97.3 | 64.9 | 69.8 | 96.9 | 50.8 | 57.8 | 98.0 | 70.3 | 74.5 | 94.5 | 61.8 | 66.7 | 96.9 | 50.4 | 57.4 | 95.9 | 65.9 | 70.5 |
| 032 | CONCRETE REINFORCEMENT | 95.1 | 74.3 | 83.4 | 95.1 | 76.4 | 84.6 | 98.5 | 77.5 | 86.7 | 104.0 | 69.1 | 84.4 | 95.1 | 76.4 | 84.6 | 97.4 | 76.7 | 85.8 |
| 033 | CAST IN PLACE CONCRETE | 101.7 | 70.2 | 88.2 | 95.5 | 48.9 | 75.6 | 101.1 | 71.2 | 88.3 | 95.6 | 57.9 | 79.5 | 95.5 | 49.5 | 75.8 | 95.5 | 53.3 | 77.5 |
| **3** | **CONCRETE** | 92.4 | 70.2 | 81.2 | 89.4 | 57.0 | 73.0 | 94.0 | 72.1 | 82.9 | 90.5 | 62.2 | 76.2 | 89.4 | 57.0 | 73.0 | 89.7 | 65.1 | 77.3 |
| **4** | **MASONRY** | 82.8 | 66.9 | 72.9 | 83.4 | 38.9 | 55.7 | 92.1 | 63.6 | 74.4 | 92.2 | 49.1 | 65.4 | 83.4 | 39.3 | 56.0 | 98.6 | 46.7 | 66.4 |
| | **METALS** | 102.2 | 92.4 | 98.5 | 96.8 | 89.0 | 93.9 | 93.7 | 74.5 | 86.4 | 92.4 | 69.4 | 83.7 | 96.7 | 89.3 | 93.9 | 91.7 | 90.1 | 91.1 |
| | **WOOD & PLASTICS** | 94.5 | 65.2 | 79.8 | 93.7 | 51.6 | 72.6 | 99.7 | 72.2 | 86.0 | 95.9 | 64.6 | 80.3 | 93.7 | 51.3 | 72.5 | 97.4 | 69.9 | 83.6 |
| **7** | **THERMAL & MOISTURE PROTECTION** | 96.6 | 64.3 | 81.7 | 96.4 | 55.7 | 77.6 | 94.2 | 70.0 | 83.0 | 93.6 | 59.5 | 77.9 | 96.1 | 55.7 | 77.5 | 95.1 | 62.9 | 80.2 |
| **8** | **DOORS & WINDOWS** | 98.1 | 60.4 | 89.0 | 95.9 | 53.7 | 85.7 | 94.2 | 67.9 | 87.9 | 90.6 | 59.3 | 83.1 | 95.9 | 53.8 | 85.7 | 94.2 | 64.8 | 87.1 |
| 092 | LATH, PLASTER & GYPSUM BOARD | 101.6 | 64.8 | 77.7 | 101.6 | 50.7 | 68.6 | 112.5 | 72.0 | 86.2 | 111.3 | 64.1 | 80.7 | 101.6 | 50.4 | 68.4 | 108.3 | 69.5 | 83.2 |
| 095 | ACOUSTICAL TREATMENT & WOOD FLOORING | 102.4 | 64.8 | 78.1 | 102.4 | 50.7 | 69.0 | 108.7 | 72.0 | 84.9 | 108.7 | 64.1 | 79.8 | 102.4 | 50.4 | 68.7 | 95.9 | 69.5 | 78.8 |
| 096 | FLOORING & CARPET | 113.0 | 67.8 | 102.1 | 113.0 | 40.4 | 95.6 | 87.8 | 75.0 | 84.8 | 86.7 | 51.5 | 78.2 | 113.0 | 41.0 | 95.7 | 87.8 | 47.5 | 78.2 |
| 099 | PAINTING & WALL COVERINGS | 104.2 | 65.4 | 81.6 | 100.9 | 50.4 | 71.5 | 99.0 | 72.1 | 83.4 | 99.0 | 47.9 | 69.3 | 100.9 | 48.3 | 70.3 | 102.4 | 59.0 | 77.2 |
| **9** | **FINISHES** | 107.7 | 65.3 | 86.1 | 105.8 | 48.1 | 76.4 | 95.1 | 71.5 | 83.1 | 94.4 | 58.6 | 76.1 | 105.7 | 47.8 | 76.2 | 91.5 | 62.0 | 76.5 |
| **10-14** | **TOTAL DIV. 10-14** | 100.0 | 76.8 | 95.1 | 100.0 | 69.5 | 93.5 | 100.0 | 75.4 | 94.8 | 100.0 | 71.0 | 93.8 | 100.0 | 69.4 | 93.5 | 100.0 | 73.6 | 94.4 |
| **15** | **MECHANICAL** | 100.0 | 68.7 | 86.2 | 100.0 | 56.8 | 80.9 | 100.1 | 71.7 | 87.5 | 100.1 | 54.0 | 79.7 | 100.0 | 46.2 | 76.2 | 100.0 | 52.1 | 78.8 |
| **16** | **ELECTRICAL** | 97.5 | 68.1 | 77.9 | 93.3 | 68.1 | 76.5 | 93.4 | 82.3 | 86.0 | 96.9 | 61.3 | 73.2 | 93.3 | 49.4 | 64.0 | 91.4 | 63.3 | 72.7 |
| **1-16** | **WEIGHTED AVERAGE** | 99.5 | 71.8 | 86.1 | 97.1 | 60.8 | 79.5 | 96.5 | 75.0 | 86.1 | 95.5 | 62.5 | 79.5 | 97.1 | 55.7 | 77.1 | 95.4 | 65.4 | 80.9 |

| DIVISION | | GEORGIA | | | | | | HAWAII | | | IDAHO | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SAVANNAH | | | VALDOSTA | | | HONOLULU | | | BOISE | | | LEWISTON | | | POCATELLO | | |
| | | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL |
| **2** | **SITE WORK** | 110.6 | 76.1 | 84.0 | 122.0 | 74.5 | 85.5 | 115.0 | 112.0 | 112.7 | 86.4 | 99.3 | 96.3 | 90.4 | 92.7 | 92.2 | 89.1 | 99.3 | 96.9 |
| 031 | CONCRETE FORMWORK | 97.0 | 60.5 | 66.0 | 80.8 | 51.9 | 56.3 | 102.1 | 158.7 | 150.1 | 97.4 | 89.3 | 90.5 | 106.3 | 87.1 | 90.0 | 97.4 | 89.3 | 90.5 |
| 032 | CONCRETE REINFORCEMENT | 100.7 | 69.5 | 83.2 | 100.8 | 50.3 | 72.5 | 109.9 | 125.0 | 118.4 | 96.0 | 78.4 | 86.1 | 108.6 | 96.1 | 101.6 | 96.3 | 78.5 | 86.3 |
| 033 | CAST IN PLACE CONCRETE | 91.5 | 56.6 | 76.6 | 93.0 | 57.4 | 77.8 | 170.2 | 127.7 | 152.0 | 98.6 | 93.8 | 96.6 | 107.8 | 93.9 | 101.8 | 99.6 | 93.8 | 97.1 |
| **3** | **CONCRETE** | 88.3 | 62.5 | 75.3 | 92.8 | 55.5 | 74.0 | 153.0 | 139.4 | 146.1 | 103.2 | 88.7 | 95.9 | 115.5 | 91.0 | 103.1 | 103.7 | 88.6 | 96.1 |
| **4** | **MASONRY** | 86.9 | 57.6 | 68.7 | 89.8 | 50.6 | 65.4 | 131.3 | 134.3 | 133.2 | 131.8 | 81.0 | 100.2 | 128.8 | 96.6 | 108.8 | 136.3 | 82.7 | 103.0 |
| **5** | **METALS** | 97.1 | 87.6 | 93.5 | 96.5 | 80.7 | 90.6 | 117.4 | 107.6 | 113.7 | 112.9 | 82.2 | 101.3 | 96.2 | 90.7 | 94.1 | 112.5 | 82.2 | 101.1 |
| **6** | **WOOD & PLASTICS** | 93.8 | 60.9 | 77.3 | 76.0 | 50.3 | 63.1 | 100.6 | 165.6 | 133.1 | 95.1 | 88.5 | 91.8 | 98.7 | 83.6 | 91.2 | 95.1 | 88.5 | 91.8 |
| **7** | **THERMAL & MOISTURE PROTECTION** | 96.4 | 59.2 | 79.3 | 96.1 | 60.0 | 79.5 | 109.5 | 133.7 | 120.6 | 97.9 | 84.0 | 91.5 | 167.6 | 89.8 | 131.7 | 98.0 | 83.8 | 91.5 |
| **8** | **DOORS & WINDOWS** | 95.9 | 56.7 | 86.4 | 91.4 | 46.3 | 80.5 | 110.6 | 146.5 | 119.2 | 94.9 | 81.7 | 91.7 | 116.3 | 85.0 | 108.7 | 94.9 | 78.5 | 91.0 |
| 092 | LATH, PLASTER & GYPSUM BOARD | 101.6 | 60.4 | 74.9 | 93.7 | 49.4 | 65.0 | 95.7 | 167.7 | 142.3 | 89.0 | 87.9 | 88.3 | 135.3 | 83.0 | 101.4 | 89.0 | 87.9 | 88.3 |
| 095 | ACOUSTICAL TREATMENT & WOOD FLOORING | 102.4 | 60.4 | 75.2 | 98.0 | 49.4 | 66.5 | 132.8 | 167.7 | 155.4 | 96.2 | 87.9 | 90.8 | 144.9 | 83.0 | 104.8 | 96.2 | 87.9 | 90.8 |
| 096 | FLOORING & CARPET | 113.0 | 60.7 | 100.4 | 105.1 | 48.5 | 91.5 | 127.8 | 128.3 | 127.9 | 97.5 | 74.8 | 92.1 | 135.1 | 97.9 | 126.2 | 97.5 | 74.8 | 92.1 |
| | PAINTING & WALL COVERINGS | 100.9 | 59.9 | 77.0 | 100.9 | 43.7 | 67.6 | 123.8 | 148.0 | 137.9 | 109.4 | 67.9 | 85.2 | 134.4 | 91.3 | 109.3 | 109.4 | 78.2 | 91.3 |
| | **FINISHES** | 105.8 | 60.5 | 82.8 | 101.9 | 50.0 | 75.5 | 124.5 | 153.9 | 139.5 | 93.2 | 84.6 | 88.8 | 156.4 | 89.0 | 122.1 | 93.2 | 85.8 | 89.4 |
| **10-14** | **TOTAL DIV. 10-14** | 100.0 | 71.7 | 94.0 | 100.0 | 70.1 | 93.7 | 100.0 | 129.2 | 106.2 | 100.0 | 86.1 | 97.0 | 100.0 | 100.6 | 100.1 | 100.0 | 86.1 | 97.0 |
| **15** | **MECHANICAL** | 100.0 | 55.8 | 80.5 | 100.0 | 48.7 | 77.3 | 100.1 | 119.4 | 108.6 | 99.8 | 85.6 | 93.5 | 100.6 | 94.1 | 97.7 | 99.8 | 85.6 | 93.5 |
| **16** | **ELECTRICAL** | 93.3 | 65.4 | 74.7 | 90.2 | 40.8 | 57.2 | 109.7 | 128.8 | 122.5 | 85.2 | 78.7 | 80.9 | 87.5 | 92.2 | 90.6 | 85.7 | 79.4 | 81.5 |
| **1-16** | **WEIGHTED AVERAGE** | 97.2 | 64.6 | 81.4 | 96.8 | 55.0 | 76.6 | 115.9 | 129.5 | 122.5 | 101.0 | 85.2 | 93.4 | 111.9 | 92.1 | 102.3 | 101.3 | 85.5 | 93.7 |

A.3.5-16

**COST INDEXES**

## ECO NUMBER 6

## REPAIR BUILDING SIDE DHW AND HVAC HOT WATER LEAKS

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-6
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-6 REPAIR DHW AND HHW LEAKS
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | | | |
|---|---|---|---|---|
| A. CONSTRUCTION COST | $ 1448. | | | |
| B. SIOH | $ 87. | | | |
| C. DESIGN COST | $ 87. | | | |
| D. TOTAL COST (1A+1B+1C) | $ 1622. | | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 1622. | |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 0. | 15.08 | $ 0. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 1111. | $ 1489. | 14.88 | $ 22152. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 1111. | $ 1489. | | $ 22152. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 530.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 7886.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 7886.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 2019.

5. SIMPLE PAYBACK PERIOD (1G/4) .80 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 30039.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 18.52
(IF < 1 PROJECT DOES NOT QUALIFY)

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. | |
| AEP Number: | 694-1331-002 | Designer: | W. T. Todd |
| Project: | Repair DHW and HHW Leaks | Date: | 02/08/96 |
| ECO Number: | 6 | | |

| | | | |
|---|---|---|---|
| Assumptions: | 1. HHW temperature | 180 | °F |
| | 2. Make-up water temperature | 70 | °F |
| | 3. Condensate temperature | 200 | °F |
| | 4. Boiler efficiency | 68% | |
| | 5. Average heating fuel cost | $1.34 | /MBtu |
| | 6. Water cost | $0.5562 | /kGallons |

| Bldg. | Leak | Location | Cup/Min | Drop/Sec | GPM | Temp.,°F | MBtu/Yr | |
|---|---|---|---|---|---|---|---|---|
| 218 | DHW | from circ. pump | 1.0 | | 0.0625 | 124 | 14.8 | |
| 512 | COND | from T at cond. tank | | 10.0 | 0.0250 | 200 | 14.2 | |
| 515 | DHW | from circ. pump | | 1.0 | 0.0025 | 123 | 0.6 | |
| 516 | DHW | from relief valve | 6.0 | | 0.3750 | 125 | 90.4 | |
| 518 | DHW | from relief valve | 3.5 | | 0.2188 | 183 | 108.4 | |
| 624 | COND | from near cond. tank | | 12.0 | 0.0300 | 200 | 17.1 | |
| 629 | HHW | from relief valve | 6.0 | | 0.3750 | 211 | 231.8 | |
| 630 | HHW | from relief valve | | 0.2 | 0.0005 | 180 | 0.2 | |
| 630 | HHW | from air separator | | 0.4 | 0.0010 | 180 | 0.5 | |
| 631 | HHW | supply side of ht ex | | 1.0 | 0.0025 | 180 | 1.2 | |
| 633 | HHW | from relief valve | | 1.0 | 0.0025 | 180 | 1.2 | |
| 636 | DHW | from HWG drain pipe | | 15.0 | 0.0375 | 138 | 11.2 | |
| 638 | HHW | from circ. pump | | 0.3 | 0.0008 | 180 | 0.4 | |
| 642 | DHW | from pipe above tank | | 5.0 | 0.0125 | 154 | 4.6 | |
| 644 | HHW | from relief valve | 1.1 | | 0.0703 | 180 | 33.9 | |
| 648 | HHW | from relief valve | | 1.0 | 0.0025 | 180 | 1.2 | |
| 706 | HHW | from circ. pump | | 3.0 | 0.0075 | 180 | 3.6 | |
| 708 | HHW | from relief valve | | 5.0 | 0.0125 | 180 | 6.0 | |
| 708 | DHW | from relief valve | 1.0 | | 0.0625 | 131 | 16.7 | |
| 722 | HHW | from circ. pump | | 2.0 | 0.0050 | 200 | 2.8 | |
| 726 | COND | at cond. tank | | 1.0 | 0.0025 | 200 | 1.4 | |
| 726 | DHW | from circ. pump | | 5.0 | 0.0125 | 158 | 4.8 | |
| 814 | HHW | from circ. pump | | 3.0 | 0.0075 | 180 | 3.6 | |
| 816 | HHW | from drain valve | | 0.1 | 0.0003 | 180 | 0.1 | |
| 1208 | HHW | from drain valve | | 0.2 | 0.0005 | 180 | 0.2 | |
| 1245 | HHW | from circ. pump | | 1.0 | 0.0025 | 180 | 1.2 | |
| 1280 | HHW | from relief valve | 7.0 | | 0.4375 | 150 | 153.4 | |
| 1509 | HHW | from relief valve | 2.1 | | 0.1328 | 180 | 64.0 | |
| 1840 | HHW | from circ. pump | | 1.0 | 0.0025 | 180 | 1.2 | |
| 29 | | Current HTW Losses | 27.8 | 68.2 | 1.9049 | GPM | 791.0 | MBtu/Yr |
| | | | x 1.00 | x 0.50 | | | | |
| | | Proposed HTW Savings | 27.8 | 34.1 | 1.8196 | GPM | 755.6 | MBtu/Yr |
| | | Proposed HTW Losses | | | 0.0853 | GPM | 35.4 | MBtu/Yr |

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

| | | | | |
|---|---|---|---|---|
| Current Fuel Use = | 791.0 MBtu/yr / | 0.68 | = | 1163.2 MBtu/Yr |
| Current Fuel Cost = | 1163.2 MBtu/yr x | $1.34 /MBtu | = | $1,559 /Year |
| New Fuel Use = | 35.4 MBtu/yr / | 0.68 | = | 52.1 MBtu/Yr |
| New Fuel Cost = | 52.1 MBtu/yr x | $1.34 /MBtu | = | $70 /Year |

Water Cost:

| | | | | |
|---|---|---|---|---|
| Current water cost = | 1001224 Gal/Yr x | $0.5562 /kGal | = | $557 /Year |
| New water cost = | 44818 Gal/Yr x | $0.5562 /kGal | = | $25 /Year |

# CONSTRUCTION COST ESTIMATE

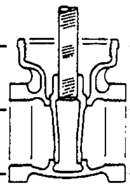
| | | | |
|---|---|---|---|
| Project: | Repair DHW and HHW Leaks in Mechanical Rooms | RS&H No.: | 694-1331-002 |
| Location: | Fort Stewart, GA | Date: | 02/14/96 |
| Basis: | Schematic Design | Estimator: | W.T.Todd |
| ECO No.: | 6 | Filename: | EST-6.WQ1 |

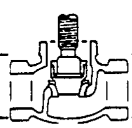
| ITEM DESCRIPTION | QUANTITY No. | QUANTITY Unit | MATERIAL/EQUIP $/Unit | MATERIAL/EQUIP Total | LABOR $/Unit | LABOR Total | TOTAL COST | SOURCE Material | SOURCE Labor |
|---|---|---|---|---|---|---|---|---|---|
| Travel time to bldgs. | 4.3 | hr | | 0 | 30.3 | 131 | 131 | | (1) |
| Repair/tighten fittings | 6.0 | hr | | 0 | 30.3 | 182 | 182 | | (2) |
| Remove P&T valves | 11 | Ea | | 0 | 10 | 110 | 110 | | MMp188 |
| 1" P & T relief valve | 11 | Ea | 79 | 869 | 10 | 110 | 979 | MMp188 | MMp188 |
| Subtotal Bare Costs | | | | 869 | | 533 | $1,402 | | |
| Retrofit Cost Factors | | | 0% | 0 | 0% | 0 | 0 | MMp6 | MMp6 |
| Subtotal | | | | 869 | | 533 | 1,402 | | |
| City Cost Index (Sav. GA) | | | 0% | 0 | -44% | -236 | (236) | MMp533 | MMp533 |
| Subtotal | | | | 869 | | 297 | 1,166 | | |
| OH & Profit Markups | | | 10% | 87 | 53% | 157 | 244 | MMp7 | MMp475 |
| Subtotal | | | | 956 | | 454 | 1,410 | | |
| Sales Taxes | | | 4.0% | 38 | | NA | 38 | MMp476 | |
| Total Construction Cost | | | | 994 | | 454 | 1,448 | | |
| Design Fee | | | | NA | 6.0% | 87 | 87 | | |
| SIOH | | | | NA | 6.0% | 87 | 87 | | |
| Subtotal | | | | 994 | | 628 | 1,622 | | |
| Contingency | | | 0% | 0 | 0% | 0 | 0 | MEp6 | MEp6 |
| Total Project Cost | | | | 994 | | 628 | $1,622 | | |

LEGEND:

| | |
|---|---|
| (1) | Estimate 10 minutes per building for 26 buildings. |
| (2) | Estimate 20 minutes per fitting for 18 fittings. |
| MMp### | 1996 Means Mechanical Cost Data, page ###. |

| 151 950 \| Valves | | Crew | Daily Output | Labor-Hours | Unit | 1996 Bare Costs Mat. | Labor | Equip. | Total | Total Incl O&P |
|---|---|---|---|---|---|---|---|---|---|---|
| 955 3420 | 3/8" size R151-090 | 1 Plum | 24 | .333 | Ea. | 18.50 | 10 | | 28.50 | 36 |
| 3430 | 1/2" size | | 24 | .333 | | 16.65 | 10 | | 26.65 | 33.50 |
| 3440 | 3/4" size | | 20 | .400 | | 19.80 | 12 | | 31.80 | 40.50 |
| 3450 | 1" size | | 19 | .421 | | 26 | 12.65 | | 38.65 | 48 |
| 3460 | 1-1/4" size | | 15 | .533 | | 35 | 16.05 | | 51.05 | 63 |
| 3470 | 1-1/2" size | | 13 | .615 | | 43 | 18.50 | | 61.50 | 76 |
| 3480 | 2" size | | 11 | .727 | | 59.50 | 22 | | 81.50 | 99 |
| 3490 | 2-1/2" size | Q-1 | 15 | 1.067 | | 138 | 29 | | 167 | 196 |
| 3500 | 3" size | | 13 | 1.231 | | 195 | 33.50 | | 228.50 | 266 |
| 3850 | Rising stem, soldered, 300 psi | | | | | | | | | |
| 3900 | 3/8" size | 1 Plum | 24 | .333 | Ea. | 25 | 10 | | 35 | 43 |
| 3920 | 1/2" size | | 24 | .333 | | 29 | 10 | | 39 | 47.50 |
| 3940 | 3/4" size | | 20 | .400 | | 37.50 | 12 | | 49.50 | 60 |
| 3950 | 1" size | | 19 | .421 | | 41 | 12.65 | | 53.65 | 65 |
| 3960 | 1-1/4" size | | 15 | .533 | | 69 | 16.05 | | 85.05 | 100 |
| 3970 | 1-1/2" size | | 13 | .615 | | 78.50 | 18.50 | | 97 | 115 |
| 3980 | 2" size | | 11 | .727 | | 110 | 22 | | 132 | 155 |
| 3990 | 2-1/2" size | Q-1 | 15 | 1.067 | | 251 | 29 | | 280 | 320 |
| 4000 | 3" size | | 13 | 1.231 | | 350 | 33.50 | | 383.50 | 435 |
| 4250 | Threaded, class 150 | | | | | | | | | |
| 4310 | 1/4" size | 1 Plum | 24 | .333 | Ea. | 16.85 | 10 | | 26.85 | 34 |
| 4320 | 3/8" size | | 24 | .333 | | 16.85 | 10 | | 26.85 | 34 |
| 4330 | 1/2" size | | 24 | .333 | | 16 | 10 | | 26 | 33 |
| 4340 | 3/4" size | | 20 | .400 | | 19.10 | 12 | | 31.10 | 39.50 |
| 4350 | 1" size | | 19 | .421 | | 25 | 12.65 | | 37.65 | 47 |
| 4360 | 1-1/4" size | | 15 | .533 | | 34 | 16.05 | | 50.05 | 62 |
| 4370 | 1-1/2" size | | 13 | .615 | | 41.50 | 18.50 | | 60 | 74 |
| 4380 | 2" size | | 11 | .727 | | 57.50 | 22 | | 79.50 | 97 |
| 4390 | 2-1/2" size | Q-1 | 15 | 1.067 | | 133 | 29 | | 162 | 190 |
| 4400 | 3" size | | 13 | 1.231 | | 187 | 33.50 | | 220.50 | 257 |
| 4500 | For 300 psi, threaded, add | | | | | 100% | 15% | | | |
| 4540 | For chain operated type, add | | | | | 15% | | | | |
| 4850 | Globe, class 150, rising stem, threaded | | | | | | | | | |
| 4920 | 1/4" size | 1 Plum | 24 | .333 | Ea. | 23.50 | 10 | | 33.50 | 41.50 |
| 4940 | 3/8" size | | 24 | .333 | | 23.50 | 10 | | 33.50 | 41.50 |
| 4950 | 1/2" size | | 24 | .333 | | 23.50 | 10 | | 33.50 | 41.50 |
| 4960 | 3/4" size | | 20 | .400 | | 32 | 12 | | 44 | 53.50 |
| 4970 | 1" size | | 19 | .421 | | 50 | 12.65 | | 62.65 | 74.50 |
| 4980 | 1-1/4" size | | 15 | .533 | | 78.50 | 16.05 | | 94.55 | 111 |
| 4990 | 1-1/2" size | | 13 | .615 | | 94.50 | 18.50 | | 113 | 133 |
| 5000 | 2" size | | 11 | .727 | | 143 | 22 | | 165 | 191 |
| 5010 | 2-1/2" size | Q-1 | 15 | 1.067 | | 287 | 29 | | 316 | 360 |
| 5020 | 3" size | | 13 | 1.231 | | 410 | 33.50 | | 443.50 | 500 |
| 5120 | For class 300, threaded, add | | | | | 50% | 15% | | | |
| 5130 | Globe, 300 lb., sweat, 3/8" size | 1 Plum | 24 | .333 | | 26 | 10 | | 36 | 44 |
| 5140 | 1/2" size | | 24 | .333 | | 26 | 10 | | 36 | 44 |
| 5150 | 3/4" size | | 20 | .400 | | 38 | 12 | | 50 | 60.50 |
| 5160 | 1" size | | 19 | .421 | | 57 | 12.65 | | 69.65 | 82 |
| 5170 | 1-1/4" size | | 15 | .533 | | 87 | 16.05 | | 103.05 | 120 |
| 5180 | 1-1/2" size | | 13 | .615 | | 104 | 18.50 | | 122.50 | 143 |
| 5190 | 2" size | | 11 | .727 | | 157 | 22 | | 179 | 207 |
| 5200 | 2-1/2" size | Q-1 | 15 | 1.067 | | 345 | 29 | | 374 | 425 |
| 5210 | 3" size | | 13 | 1.231 | | 505 | 33.50 | | 538.50 | 605 |
| 5600 | Relief, pressure & temperature, self-closing, ASME | | | | | | | | | |
| 5640 | 3/4" size | 1 Plum | 28 | .286 | Ea. | 51.50 | 8.60 | | 60.10 | 69.50 |
| 5650 | 1" size | | 24 | .333 | | 79 | 10 | | 89 | 102 |





A.3.6-5

# Installing Contractor's Overhead & Profit

Below are the **average** installing contractor's percentage mark-ups applied to base labor rates to arrive at typical billing rates.

**Column A:** Labor rates are based on union wages averaged for 30 major U.S. cities. Base rates including fringe benefits are listed hourly and daily. These figures are the sum of the wage rate and employer-paid fringe benefits such as vacation pay, employer-paid health and welfare costs, pension costs, plus appropriate training and industry advancement funds costs.

**Column B:** Workers' Compensation rates are the national average of state rates established for each trade.

**Column C:** Column C lists average fixed overhead figures for all trades. Included are Federal and State Unemployment costs set at 7.3%; Social Security Taxes (FICA) set at 7.65%; Builder's Risk Insurance costs set at 0.34%; and Public Liability costs set at 1.55%. All the percentages except those for Social Security Taxes vary from state to state as well as from company to company.

**Columns D and E:** Percentages in Columns D and E are based on the presumption that the installing contractor has annual billing of $500,000 and up. Overhead percentages may increase with smaller annual billing. The overhead percentages for any given contractor may vary greatly and depend on a number of factors, such as the contractor's annual volume, engineering and logistical support costs, and staff requirements. The figures for overhead and profit will also vary depending on the type of job, the job location, and the prevailing economic conditions. All factors should be examined very carefully for each job.

**Column F:** Column F lists the total of Columns B, C, D, and E.

**Column G:** Column G is Column A (hourly base labor rate) multiplied by the percentage in Column F (O&P percentage).

**Column H:** Column H is the total of Column A (hourly base labor rate) plus Column G (Total O&P).

**Column I:** Column I is Column H multiplied by eight hours.

| | | A | | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Base Rate Incl. Fringes | | Workers' Comp. Ins. | Average Fixed Overhead | Overhead | Profit | Total Overhead & Profit | | Rate with O & P | |
| Abbr. | Trade | Hourly | Daily | | | | | % | Amount | Hourly | Daily |
| Skwk | Skilled Workers Average (35 trades) | $25.95 | $207.60 | 20.2% | 16.8% | 13.0% | 10% | 60.0% | $15.55 | $41.50 | $332.00 |
| | Helpers Average (5 trades) | 19.25 | 154.00 | 21.4 | | 11.0 | | 59.2 | 11.40 | 30.65 | 245.20 |
| | Foreman Average, Inside ($.50 over trade) | 26.45 | 211.60 | 20.2 | | 13.0 | | 60.0 | 15.85 | 42.30 | 338.40 |
| | Foreman Average, Outside ($2.00 over trade) | 27.95 | 223.60 | 20.2 | | 13.0 | | 60.0 | 16.75 | 44.70 | 357.60 |
| Clab | Common Building Laborers | 19.80 | 158.40 | 21.9 | | 11.0 | | 59.7 | 11.80 | 31.60 | 252.80 |
| Asbe | Asbestos Workers | 28.55 | 228.40 | 19.7 | | 16.0 | | 62.5 | 17.85 | 46.40 | 371.20 |
| Boil | Boilermakers | 30.05 | 240.40 | 17.7 | | 16.0 | | 60.5 | 18.20 | 48.25 | 386.00 |
| Bric | Bricklayers | 25.90 | 207.20 | 19.4 | | 11.0 | | 57.2 | 14.80 | 40.70 | 325.60 |
| Brhe | Bricklayer Helpers | 20.00 | 160.00 | 19.4 | | 11.0 | | 57.2 | 11.45 | 31.45 | 251.60 |
| Carp | Carpenters | 25.20 | 201.60 | 21.9 | | 11.0 | | 59.7 | 15.05 | 40.25 | 322.00 |
| Cefi | Cement Finishers | 24.35 | 194.80 | 12.8 | | 11.0 | | 50.6 | 12.30 | 36.65 | 293.20 |
| Elec | Electricians | 29.30 | 234.40 | 8.0 | | 16.0 | | 50.8 | 14.90 | 44.20 | 353.60 |
| Elev | Elevator Constructors | 30.05 | 240.40 | 9.6 | | 16.0 | | 52.4 | 15.75 | 45.80 | 366.40 |
| Eqhv | Equipment Operators, Crane or Shovel | 26.75 | 214.00 | 12.9 | | 14.0 | | 53.7 | 14.35 | 41.10 | 328.80 |
| Eqmd | Equipment Operators, Medium Equipment | 25.70 | 205.60 | 12.9 | | 14.0 | | 53.7 | 13.80 | 39.50 | 316.00 |
| Eqlt | Equipment Operators, Light Equipment | 24.70 | 197.60 | 12.9 | | 14.0 | | 53.7 | 13.25 | 37.95 | 303.60 |
| Eqol | Equipment Operators, Oilers | 21.90 | 175.20 | 12.9 | | 14.0 | | 53.7 | 11.75 | 33.65 | 269.20 |
| Eqmm | Equipment Operators, Master Mechanics | 27.55 | 220.40 | 12.9 | | 14.0 | | 53.7 | 14.80 | 42.35 | 338.80 |
| Glaz | Glaziers | 24.90 | 199.20 | 16.0 | | 11.0 | | 53.8 | 13.40 | 38.30 | 306.40 |
| Lath | Lathers | 24.95 | 199.60 | 13.5 | | 11.0 | | 51.3 | 12.80 | 37.75 | 302.00 |
| Marb | Marble Setters | 25.65 | 205.20 | 19.4 | | 11.0 | | 57.2 | 14.65 | 40.30 | 322.40 |
| Mill | Millwrights | 26.55 | 212.40 | 13.2 | | 11.0 | | 51.0 | 13.55 | 40.10 | 320.80 |
| Mstz | Mosaic & Terrazzo Workers | 25.25 | 202.00 | 11.0 | | 11.0 | | 48.8 | 12.30 | 37.55 | 300.40 |
| Pord | Painters, Ordinary | 22.95 | 183.60 | 16.8 | | 11.0 | | 54.6 | 12.55 | 35.50 | 284.00 |
| Psst | Painters, Structural Steel | 23.95 | 191.60 | 62.5 | | 11.0 | | 100.3 | 24.00 | 47.95 | 383.60 |
| Pape | Paper Hangers | 23.30 | 186.40 | 16.8 | | 11.0 | | 54.6 | 12.70 | 36.00 | 288.00 |
| Pile | Pile Drivers | 25.35 | 202.80 | 33.6 | | 16.0 | | 76.4 | 19.35 | 44.70 | 357.60 |
| Plas | Plasterers | 24.20 | 193.60 | 17.4 | | 11.0 | | 55.2 | 13.35 | 37.55 | 300.40 |
| Plah | Plasterer Helpers | 20.15 | 161.20 | 17.4 | | 11.0 | | 55.2 | 11.10 | 31.25 | 250.00 |
| Plum | Plumbers | 30.05 | 240.40 | 10.2 | | 16.0 | | 53.0 | 15.95 | 46.00 | 368.00 |
| Rodm | Rodmen (Reinforcing) | 27.75 | 222.00 | 36.3 | | 14.0 | | 77.1 | 21.40 | 49.15 | 393.20 |
| Rofc | Roofers, Composition | 22.55 | 180.40 | 37.4 | | 11.0 | | 75.2 | 16.95 | 39.50 | 316.00 |
| Rots | Roofers, Tile & Slate | 22.60 | 180.80 | 37.4 | | 11.0 | | 75.2 | 17.00 | 39.60 | 316.80 |
| Rohe | Roofers, Helpers (Composition) | 15.95 | 127.60 | 37.4 | | 11.0 | | 75.2 | 12.00 | 27.95 | 223.60 |
| Shee | Sheet Metal Workers | 28.95 | 231.60 | 13.8 | | 16.0 | | 56.6 | 16.40 | 45.35 | 362.80 |
| Spri | Sprinkler Installers | 31.30 | 250.40 | 10.4 | | 16.0 | | 53.2 | 16.65 | 47.95 | 383.60 |
| Stpi | Steamfitters or Pipefitters | 30.30 | 242.40 | 10.2 | | 16.0 | | 53.0 | 16.05 | 46.35 | 370.80 |
| Ston | Stone Masons | 25.90 | 207.20 | 19.4 | | 11.0 | | 57.2 | 14.80 | 40.70 | 325.60 |
| Sswk | Structural Steel Workers | 27.85 | 222.80 | 46.4 | | 14.0 | | 87.2 | 24.30 | 52.15 | 417.20 |
| Tilf | Tile Layers | 25.05 | 200.40 | 11.0 | | 11.0 | | 48.8 | 12.20 | 37.25 | 298.00 |
| Tilh | Tile Layers Helpers | 20.30 | 162.40 | 11.0 | | 11.0 | | 48.8 | 9.90 | 30.20 | 241.60 |
| Trlt | Truck Drivers, Light | 20.35 | 162.80 | 17.0 | | 11.0 | | 54.8 | 11.15 | 31.50 | 252.00 |
| Trhv | Truck Drivers, Heavy | 20.70 | 165.60 | 17.0 | | 11.0 | | 54.8 | 11.35 | 32.05 | 256.40 |
| Sswl | Welders, Structural Steel | 27.85 | 222.80 | 46.4 | | 14.0 | | 87.2 | 24.30 | 52.15 | 417.20 |
| Wrck | *Wrecking | 19.80 | 158.40 | 44.8 | | 11.0 | | 82.6 | 16.35 | 36.15 | 289.20 |

*Not included in Averages.

| | DIVISION | FLORIDA | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MIAMI | | | ORLANDO | | | PANAMA CITY | | | PENSACOLA | | | ST. PETERSBURG | | | TALLAHASSEE | | |
| | | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL |
| 2 | SITE WORK | 110.3 | 72.8 | 81.5 | 125.3 | 85.9 | 95.0 | 141.6 | 83.4 | 96.9 | 138.9 | 85.9 | 98.1 | 126.2 | 85.6 | 95.0 | 125.7 | 85.2 | 94.6 |
| 031 | CONCRETE FORMWORK | 94.2 | 71.0 | 74.5 | 97.3 | 71.6 | 75.5 | 95.8 | 37.8 | 46.6 | 84.5 | 69.7 | 72.0 | 94.1 | 64.8 | 69.3 | 97.3 | 53.0 | 59.7 |
| 032 | CONCRETE REINFORCEMENT | 95.1 | 72.5 | 82.4 | 95.1 | 79.0 | 86.0 | 99.3 | 64.5 | 79.7 | 101.5 | 64.9 | 81.0 | 98.5 | 74.3 | 84.9 | 95.1 | 65.2 | 78.3 |
| 033 | CAST IN PLACE CONCRETE | 91.5 | 75.4 | 84.6 | 88.7 | 78.0 | 84.1 | 95.2 | 43.0 | 72.9 | 95.2 | 69.0 | 84.0 | 101.4 | 70.2 | 88.1 | 91.7 | 58.4 | 77.5 |
| 3 | CONCRETE | 87.4 | 74.3 | 80.8 | 86.3 | 76.7 | 81.4 | 95.0 | 46.6 | 70.5 | 93.5 | 70.1 | 81.7 | 92.6 | 70.1 | 81.2 | 87.7 | 59.2 | 73.3 |
| 4 | MASONRY | 76.9 | 70.2 | 72.8 | 77.4 | 75.6 | 76.2 | 84.9 | 37.4 | 55.4 | 82.6 | 67.6 | 73.3 | 119.2 | 66.9 | 86.7 | 83.6 | 52.6 | 64.4 |
| 5 | METALS | 98.8 | 93.5 | 96.8 | 107.9 | 95.0 | 103.0 | 97.2 | 75.1 | 88.9 | 97.1 | 89.6 | 94.3 | 101.0 | 92.4 | 97.7 | 99.2 | 88.1 | 95.0 |
| 6 | WOOD & PLASTICS | 88.6 | 72.7 | 80.6 | 94.5 | 71.1 | 82.8 | 92.9 | 38.3 | 65.6 | 80.1 | 71.1 | 75.6 | 90.8 | 65.2 | 78.0 | 94.5 | 51.6 | 73.0 |
| 7 | THERMAL & MOISTURE PROTECTION | 99.6 | 74.6 | 88.0 | 96.6 | 75.6 | 86.9 | 96.9 | 38.3 | 69.9 | 96.6 | 66.9 | 82.9 | 96.3 | 63.1 | 81.0 | 96.6 | 58.8 | 79.1 |
| 8 | DOORS & WINDOWS | 95.9 | 69.5 | 89.5 | 98.1 | 68.2 | 90.9 | 95.7 | 35.2 | 81.2 | 95.7 | 66.5 | 88.7 | 96.8 | 60.4 | 88.0 | 98.1 | 53.9 | 87.4 |
| 092 | LATH, PLASTER & GYPSUM BOARD | 101.0 | 72.5 | 82.5 | 101.6 | 70.8 | 81.7 | 99.7 | 36.9 | 59.0 | 94.5 | 70.9 | 79.2 | 98.9 | 64.8 | 76.8 | 101.6 | 50.7 | 68.6 |
| 095 | ACOUSTICAL TREATMENT & WOOD FLOORING | 102.4 | 72.5 | 83.0 | 102.4 | 70.8 | 82.0 | 96.6 | 36.9 | 58.0 | 96.6 | 70.9 | 79.9 | 98.0 | 64.8 | 76.5 | 102.4 | 50.7 | 68.9 |
| 096 | FLOORING & CARPET | 121.8 | 75.3 | 110.7 | 113.0 | 74.9 | 103.8 | 112.3 | 24.6 | 91.3 | 106.7 | 68.0 | 97.4 | 111.4 | 67.8 | 100.9 | 113.0 | 49.7 | 97.8 |
| 099 | PAINTING & WALL COVERINGS | 100.9 | 70.1 | 83.0 | 104.2 | 77.6 | 88.7 | 104.2 | 34.5 | 63.7 | 104.2 | 78.5 | 89.3 | 104.2 | 65.4 | 81.6 | 104.2 | 55.7 | 76.0 |
| 9 | FINISHES | 108.6 | 71.4 | 89.7 | 107.7 | 72.7 | 89.9 | 107.2 | 34.4 | 70.2 | 104.5 | 70.5 | 87.2 | 106.0 | 65.3 | 85.3 | 107.7 | 51.9 | 79.3 |
| 10-14 | TOTAL DIV. 10-14 | 100.0 | 81.8 | 96.1 | 100.0 | 83.9 | 96.6 | 100.0 | 65.4 | 92.6 | 100.0 | 73.3 | 94.3 | 100.0 | 76.8 | 95.1 | 100.0 | 74.0 | 94.5 |
| 15 | MECHANICAL | 100.0 | 72.9 | 88.0 | 100.0 | 70.8 | 87.1 | 100.0 | 34.6 | 71.1 | 100.0 | 68.8 | 86.2 | 100.0 | 68.7 | 86.2 | 100.0 | 54.8 | 80.0 |
| 16 | ELECTRICAL | 98.0 | 84.9 | 89.3 | 98.0 | 63.0 | 74.6 | 96.3 | 47.1 | 63.5 | 101.8 | 63.4 | 76.2 | 98.5 | 68.1 | 78.2 | 98.0 | 58.3 | 71.5 |
| 1-16 | WEIGHTED AVERAGE | 97.5 | 76.7 | 87.4 | 99.2 | 75.1 | 87.6 | 99.2 | 48.1 | 74.5 | 98.8 | 71.8 | 85.7 | 101.0 | 71.8 | 86.9 | 98.5 | 62.1 | 80.9 |

| | DIVISION | FLORIDA | | | GEORGIA | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | TAMPA | | | ALBANY | | | ATLANTA | | | AUGUSTA | | | COLUMBUS | | | MACON | | |
| | | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL |
| 2 | SITE WORK | 126.9 | 85.6 | 95.1 | 110.4 | 74.2 | 82.5 | 114.3 | 92.8 | 97.8 | 110.2 | 91.5 | 95.8 | 110.4 | 74.3 | 82.6 | 111.6 | 91.9 | 96.5 |
| 031 | CONCRETE FORMWORK | 97.3 | 64.9 | 69.8 | 96.9 | 50.8 | 57.8 | 98.0 | 70.3 | 74.5 | 94.5 | 61.8 | 66.7 | 96.9 | 50.4 | 57.4 | 95.9 | 65.9 | 70.5 |
| 032 | CONCRETE REINFORCEMENT | 95.1 | 74.3 | 83.4 | 95.1 | 76.4 | 84.6 | 98.5 | 77.5 | 86.7 | 104.0 | 69.1 | 84.4 | 95.1 | 76.4 | 84.6 | 97.4 | 76.7 | 85.8 |
| 033 | CAST IN PLACE CONCRETE | 101.7 | 70.2 | 88.2 | 95.5 | 48.9 | 75.6 | 101.1 | 71.2 | 88.3 | 95.6 | 57.9 | 79.5 | 95.5 | 49.5 | 75.8 | 95.5 | 53.3 | 77.5 |
| 3 | CONCRETE | 92.4 | 70.2 | 81.2 | 89.4 | 57.0 | 73.0 | 94.0 | 72.1 | 82.9 | 90.5 | 62.2 | 76.2 | 89.4 | 57.0 | 73.0 | 89.7 | 65.1 | 77.3 |
| 4 | MASONRY | 82.8 | 66.9 | 72.9 | 83.4 | 38.9 | 55.7 | 92.1 | 63.6 | 74.4 | 92.2 | 49.1 | 65.4 | 83.4 | 39.3 | 56.0 | 98.6 | 46.7 | 66.4 |
| | METALS | 102.2 | 92.4 | 98.5 | 96.8 | 89.0 | 93.9 | 93.7 | 74.5 | 86.4 | 92.4 | 69.4 | 83.7 | 96.7 | 89.3 | 93.9 | 91.7 | 90.1 | 91.1 |
| | WOOD & PLASTICS | 94.5 | 65.2 | 79.8 | 93.7 | 51.6 | 72.6 | 99.7 | 72.2 | 86.0 | 95.9 | 64.6 | 80.3 | 93.7 | 51.3 | 72.5 | 97.4 | 69.9 | 83.6 |
| 7 | THERMAL & MOISTURE PROTECTION | 96.6 | 64.3 | 81.7 | 96.4 | 55.7 | 77.6 | 94.2 | 70.0 | 83.0 | 93.6 | 59.5 | 77.9 | 96.1 | 55.7 | 77.5 | 95.1 | 62.9 | 80.2 |
| 8 | DOORS & WINDOWS | 98.1 | 60.4 | 89.0 | 95.9 | 53.7 | 85.7 | 94.2 | 67.9 | 87.9 | 90.6 | 59.3 | 83.1 | 95.9 | 53.8 | 85.7 | 94.2 | 64.8 | 87.1 |
| 092 | LATH, PLASTER & GYPSUM BOARD | 101.6 | 64.8 | 77.7 | 101.6 | 50.7 | 68.6 | 112.5 | 72.0 | 86.2 | 111.3 | 64.1 | 80.7 | 101.6 | 50.4 | 68.4 | 108.3 | 69.5 | 83.2 |
| 095 | ACOUSTICAL TREATMENT & WOOD FLOORING | 102.4 | 64.8 | 78.1 | 102.4 | 50.7 | 69.0 | 108.7 | 72.0 | 84.9 | 108.7 | 64.1 | 79.8 | 102.4 | 50.4 | 68.7 | 95.9 | 69.5 | 78.8 |
| 096 | FLOORING & CARPET | 113.0 | 67.8 | 102.1 | 113.0 | 40.4 | 95.6 | 87.8 | 75.0 | 84.8 | 86.7 | 51.5 | 78.2 | 113.0 | 41.0 | 95.7 | 87.8 | 47.5 | 78.2 |
| 099 | PAINTING & WALL COVERINGS | 104.2 | 65.4 | 81.6 | 100.9 | 50.4 | 71.5 | 99.0 | 72.1 | 83.4 | 99.0 | 47.9 | 69.3 | 100.9 | 48.3 | 70.3 | 102.4 | 59.0 | 77.2 |
| 9 | FINISHES | 107.7 | 65.3 | 86.1 | 105.8 | 48.1 | 76.4 | 95.1 | 71.5 | 83.1 | 94.4 | 58.6 | 76.1 | 105.7 | 47.8 | 76.2 | 91.5 | 62.0 | 76.5 |
| 10-14 | TOTAL DIV. 10-14 | 100.0 | 76.8 | 95.1 | 100.0 | 69.5 | 93.5 | 100.0 | 75.4 | 94.8 | 100.0 | 71.0 | 93.8 | 100.0 | 69.4 | 93.5 | 100.0 | 73.6 | 94.4 |
| 15 | MECHANICAL | 100.0 | 68.7 | 86.2 | 100.0 | 56.8 | 80.9 | 100.1 | 71.7 | 87.5 | 100.1 | 54.0 | 79.7 | 100.0 | 46.2 | 76.2 | 100.0 | 52.1 | 78.8 |
| 16 | ELECTRICAL | 97.5 | 68.1 | 77.9 | 93.3 | 68.1 | 76.5 | 93.4 | 82.3 | 86.0 | 96.9 | 61.3 | 73.2 | 93.3 | 49.4 | 64.0 | 91.4 | 63.3 | 72.7 |
| 1-16 | WEIGHTED AVERAGE | 99.5 | 71.8 | 86.1 | 97.1 | 60.8 | 79.5 | 96.5 | 75.0 | 86.1 | 95.5 | 62.5 | 79.5 | 97.1 | 55.7 | 77.1 | 95.4 | 65.4 | 80.9 |

| | DIVISION | GEORGIA | | | | | | HAWAII | | | IDAHO | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SAVANNAH | | | VALDOSTA | | | HONOLULU | | | BOISE | | | LEWISTON | | | POCATELLO | | |
| | | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL |
| 2 | SITE WORK | 110.6 | 76.1 | 84.0 | 122.0 | 74.5 | 85.5 | 115.0 | 112.0 | 112.7 | 86.4 | 99.3 | 96.3 | 90.4 | 92.7 | 92.2 | 89.1 | 99.3 | 96.9 |
| 031 | CONCRETE FORMWORK | 97.0 | 60.5 | 66.0 | 80.8 | 51.9 | 56.3 | 102.1 | 158.7 | 150.1 | 97.4 | 89.3 | 90.5 | 106.3 | 87.1 | 90.0 | 97.4 | 89.3 | 90.5 |
| 032 | CONCRETE REINFORCEMENT | 100.7 | 69.5 | 83.2 | 100.8 | 50.3 | 72.5 | 109.9 | 125.0 | 118.4 | 96.0 | 78.4 | 86.1 | 108.6 | 96.1 | 101.6 | 96.3 | 78.5 | 86.3 |
| 033 | CAST IN PLACE CONCRETE | 91.5 | 56.6 | 76.6 | 93.0 | 57.4 | 77.8 | 170.2 | 127.7 | 152.0 | 98.6 | 93.8 | 96.6 | 107.8 | 93.9 | 101.8 | 99.6 | 93.8 | 97.1 |
| 3 | CONCRETE | 88.3 | 62.5 | 75.3 | 92.8 | 55.5 | 74.0 | 153.0 | 139.4 | 146.1 | 103.2 | 88.7 | 95.9 | 115.5 | 91.0 | 103.1 | 103.7 | 88.6 | 96.1 |
| 4 | MASONRY | 86.9 | 57.6 | 68.7 | 89.8 | 50.6 | 65.4 | 131.3 | 134.3 | 133.2 | 131.8 | 81.0 | 100.2 | 128.8 | 96.6 | 108.8 | 136.3 | 82.7 | 103.0 |
| 5 | METALS | 97.1 | 87.6 | 93.5 | 96.5 | 80.7 | 90.6 | 117.4 | 107.6 | 113.7 | 112.9 | 82.2 | 101.3 | 96.2 | 90.7 | 94.1 | 112.5 | 82.2 | 101.1 |
| 6 | WOOD & PLASTICS | 93.8 | 60.9 | 77.3 | 76.0 | 50.3 | 63.1 | 100.6 | 165.6 | 133.1 | 95.1 | 88.5 | 91.8 | 98.7 | 83.6 | 91.2 | 95.1 | 88.5 | 91.8 |
| 7 | THERMAL & MOISTURE PROTECTION | 96.4 | 59.2 | 79.3 | 96.1 | 60.0 | 79.5 | 109.5 | 133.7 | 120.6 | 97.9 | 84.0 | 91.5 | 167.6 | 89.8 | 131.7 | 98.0 | 83.8 | 91.5 |
| 8 | DOORS & WINDOWS | 95.9 | 56.7 | 86.4 | 91.4 | 46.3 | 80.5 | 110.6 | 146.5 | 119.2 | 94.9 | 81.7 | 91.7 | 116.3 | 85.0 | 108.7 | 94.9 | 78.5 | 91.0 |
| 092 | LATH, PLASTER & GYPSUM BOARD | 101.6 | 60.4 | 74.9 | 93.7 | 49.4 | 65.0 | 95.7 | 167.7 | 142.3 | 89.0 | 87.9 | 88.3 | 135.3 | 83.0 | 101.4 | 89.0 | 87.9 | 88.3 |
| 095 | ACOUSTICAL TREATMENT & WOOD FLOORING | 102.4 | 60.4 | 75.2 | 98.0 | 49.4 | 66.5 | 132.8 | 167.7 | 155.4 | 96.2 | 87.9 | 90.8 | 144.9 | 83.0 | 104.8 | 96.2 | 87.9 | 90.8 |
| 096 | FLOORING & CARPET | 113.0 | 60.7 | 100.4 | 105.1 | 48.5 | 91.5 | 127.8 | 128.3 | 127.9 | 97.5 | 74.8 | 92.1 | 135.1 | 97.9 | 126.2 | 97.5 | 74.8 | 92.1 |
| | PAINTING & WALL COVERINGS | 100.9 | 59.9 | 77.0 | 100.9 | 43.7 | 67.6 | 123.8 | 148.0 | 137.9 | 109.4 | 67.9 | 85.2 | 134.4 | 91.3 | 109.3 | 109.4 | 78.2 | 91.3 |
| | FINISHES | 105.8 | 60.5 | 82.8 | 101.9 | 50.0 | 75.5 | 124.5 | 153.9 | 139.5 | 93.2 | 84.6 | 88.8 | 156.4 | 89.0 | 122.1 | 93.2 | 85.8 | 89.4 |
| 10-14 | TOTAL DIV. 10-14 | 100.0 | 71.7 | 94.0 | 100.0 | 70.1 | 93.7 | 100.0 | 129.2 | 106.2 | 100.0 | 86.1 | 97.0 | 100.0 | 100.6 | 100.1 | 100.0 | 86.1 | 97.0 |
| 15 | MECHANICAL | 100.0 | 55.8 | 80.5 | 100.0 | 48.7 | 77.3 | 100.1 | 119.4 | 108.6 | 99.8 | 85.6 | 93.5 | 100.6 | 94.1 | 97.7 | 99.8 | 85.6 | 93.5 |
| 16 | ELECTRICAL | 93.3 | 65.4 | 74.7 | 90.2 | 40.8 | 57.2 | 109.7 | 128.8 | 122.5 | 85.2 | 78.7 | 80.9 | 87.5 | 92.2 | 90.6 | 85.7 | 79.4 | 81.5 |
| 1-16 | WEIGHTED AVERAGE | 97.2 | 64.6 | 81.4 | 96.8 | 55.0 | 76.6 | 115.9 | 129.5 | 122.5 | 101.0 | 85.2 | 93.4 | 111.9 | 92.1 | 102.3 | 101.3 | 85.5 | 93.7 |

A.3.6-7

## ECO NUMBER 7

## REPAIR HTW LEAKS IN VALVE PITS

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-7
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-7 REPAIR HTW LEAKS IN VALVE PITS
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | | | |
|---|---|---|---|---|
| A. CONSTRUCTION COST | $ 2480. | | | |
| B. SIOH | $ 149. | | | |
| C. DESIGN COST | $ 149. | | | |
| D. TOTAL COST (1A+1B+1C) | $ 2778. | | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 2778. | |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 2. | $ 33. | 15.08 | $ 497. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 1873. | $ 2510. | 14.88 | $ 37346. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 1875. | $ 2543. | | $ 37843. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 275.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 4092.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 4092.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 2818.

5. SIMPLE PAYBACK PERIOD (1G/4) .99 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 41935.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 15.10
(IF < 1 PROJECT DOES NOT QUALIFY)

WITH ECO'S 9A & 12A

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-7X
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-7 REPAIR HTW LEAKS IN VALVE PITS
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-15-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | | | |
|---|---|---|---|---|
| A. CONSTRUCTION COST | $ 2480. | | | |
| B. SIOH | $ 149. | | | |
| C. DESIGN COST | $ 149. | | | |
| D. TOTAL COST (1A+1B+1C) | $ 2778. | | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ | 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ | 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | | $ 2778. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 2. | $ 33. | 15.08 | $ 497. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 1619. | $ 2169. | 14.88 | $ 32282. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 1621. | $ 2202. | | $ 32779. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 275.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 4092.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 4092.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 2477.

5. SIMPLE PAYBACK PERIOD (1G/4) 1.12 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 36871.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 13.27
(IF < 1 PROJECT DOES NOT QUALIFY)

WITH ECO's 9A, 12A & 12B

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-7Y
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-7 REPAIR HTW LEAKS IN VALVE PITS
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-15-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT
A. CONSTRUCTION COST $ 2480.
B. SIOH $ 149.
C. DESIGN COST $ 149.
D. TOTAL COST (1A+1B+1C) $ 2778.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 2778.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 2. | $ 33. | 15.08 | $ 497. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 1432. | $ 1919. | 14.88 | $ 28553. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 1434. | $ 1952. | | $ 29050. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 275.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 4092.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 4092.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 2227.

5. SIMPLE PAYBACK PERIOD (1G/4) 1.25 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 33142.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 11.93
(IF < 1 PROJECT DOES NOT QUALIFY)

RS&H

SUBJECT FORT STEWART
REPAIR LEAKS IN VALVE PITS
DESIGNER W. TODD
CHECKER

AEP NO 694 1331 002
SHEET ____ OF ____
DATE 2-8-96
DATE

ECO-7 SUMMARY

ANNUAL SAVINGS

ELECTRICITY = 2.5 - 0.1 = $\boxed{2.4 \text{ mBtu/YR}}$

HEATING FUELS = 1942 - 69 = $\boxed{1873 \text{ mBtu/YR}}$

WATER = \$284 - \$10 = $\boxed{\$274/\text{YR}}$

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. | |
| AEP Number: | 694-1331-002 | Designer: | W. T. Todd |
| Project: | Existing Leaks in Valve Pits | Date: | 02/08/96 |
| ECO Number: | 7 | | |

Assumptions:

1. HTW temperature — 380 °F
2. Make-up water temperature — 70 °F
3. Boiler efficiency — 68%
4. Pump head (from record drawings) — 300 Ft H20
5. Pump efficiency (from record drawings — 72%
6. Motor efficiency — 90%
7. Average heating fuel cost — $1.34 /MBtu
8. Electricity cost — $0.0469 /kWh
9. Water cost — $0.5562 /kGallons

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

510360 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 1320.3 MBtu/Yr

Heating Fuel Use = 1320.3 MBtu/yr / 0.68 = 1941.6 MBtu/Yr

Heating Fuel Cost = 1941.6 MBtu/yr x $1.34 /MBtu = $2,602 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$BHP = \frac{0.97 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.10 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency ) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.10 BHP / 0.90 x 0.746 kW/HP = 0.08 kW

Electricity Use = 0.08 kW x 8760 Hr/Yr = 742 kWh/Yr

Electricity Use = 742 kWh/Yr x 0.003413 MBtu/kWh = 2.5 MBtu/Yr

Electricity Cost = 742 kWh/Yr x $0.0469 /kWh = $35 /Year

Water Cost:

510360 Gal/Yr x $0.5562 /kGal = $284 /Year

Total Utility Cost:

| | | |
|---|---|---|
| Heating Fuel Cost | $2,602 | /Year |
| Pumping (Elec) Cost | $35 | /Year |
| Water Cost | $284 | /Year |
| Total Utility Cost | $2,921 | /Year |

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. | |
| AEP Number: | 694-1331-002 | Designer: | W. T. Todd |
| Project: | Repair Leaks in Valve Pits | Date: | 02/08/96 |
| ECO Number: | 7 | | |

Assumptions:

| | | |
|---|---|---|
| 1. HTW temperature | 380 | °F |
| 2. Make-up water temperature | 70 | °F |
| 3. Boiler efficiency | 68% | |
| 4. Pump head (from record drawings) | 300 | Ft H20 |
| 5. Pump efficiency (from record drawings | 72% | |
| 6. Motor efficiency | 90% | |
| 7. Average heating fuel cost | $1.34 | /MBtu |
| 8. Electricity cost | $0.0469 | /kWh |
| 9. Water cost | $0.5562 | /kGallons |

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

18130 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 46.9 MBtu/Yr

Heating Fuel Use = 46.9 MBtu/yr / 0.68 = 69.0 MBtu/Yr

Heating Fuel Cost = 69.0 MBtu/yr x $1.34 /MBtu = $92 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$\text{BHP} = \frac{0.03 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.00 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency ) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.00 BHP / 0.90 x 0.746 kW/HP = 0.00 kW

Electricity Use = 0.00 kW x 8760 Hr/Yr = 26 kWh/Yr

Electricity Use = 26 kWh/Yr x 0.003413 MBtu/kWh = 0.1 MBtu/Yr

Electricity Cost = 26 kWh/Yr x $0.0469 /kWh = $1 /Year

Water Cost:

18130 Gal/Yr x $0.5562 /kGal = $10 /Year

Total Utility Cost:

| | | |
|---|---|---|
| Heating Fuel Cost | $92 | /Year |
| Pumping (Elec) Cost | $1 | /Year |
| Water Cost | $10 | /Year |
| Total Utility Cost | $103 | /Year |

**RS&H**

| | | | |
|---|---|---|---|
| SUBJECT | Fort Stewart | AEP NO | 694 1331 002 |
| | Repair Leaks in Valve Pits | SHEET | OF |
| DESIGNER | W. Todd | DATE | 2-5-96 |
| CHECKER | | DATE | |

| Valve Pit No. / Near | Drops / Sec | Stream Dia. / GPM | Leak From |
|---|---|---|---|
| VP-1-11 / 704 | 1/3 | — — | Valve |
| VP-1-16 / 726 | 3+2 | — — | ↓ |
| VP-2N-5 / 1820 | 5+ | — — | ↓ |
| VP-2S-1 / 6th St. | 2 | — — | ↓ |
| VP-2S-3 / 517 | 2 | — — | ↓ |
| VP-2S-8 / 512 | 2+2 | — — | 2 valves |
| VP-3-1 / 1540 | 2 | 1/4" / 0.438 | Flange |
| VP-3-5 / 1170 | 1/10 + 2 | — — | Valve |
| VP-3-11 / 419 | — | 1/8" / 0.109 | " |
| VP-3-15 / 200 blk Field | — | 1/8" / 0.109 | Flange |
| VP-3-16 / 225 | — | 3/16" / 0.246 | ↓ |
| VP-3-18 / 218 | 2 | — — | ↓ |
| VP-3-27 / 213 | 1+2 | — — | ↓ |
| Totals 13 Pits | 27.4 D/s | 0.902 GPM | |

Minor Leaks :

$$27.4 \text{ drop/s} \times 2.5 \times 10^{-3} \frac{\text{GPM}}{\text{d/s}} = 0.069 \text{ GPM} = 36{,}270 \frac{\text{GAL}}{\text{YR}}$$

Proposed HTW losses : Assume 50% of minor leaks

$$0.069 \text{ GPM} \times 1440 \frac{\text{min}}{\text{day}} \times 365 \frac{\text{day}}{\text{YR}} \times 0.5 = \underline{18130 \frac{\text{GAL}}{\text{YR}}}$$

Major Leaks : (Assume 100% can be repaired)

$$0.902 \text{ GPM} \times 1440 \text{ min/day} \times 365 \text{ day/YR} = 474{,}090 \text{ GAL/YR}$$

Current HTW Losses :

$$474090 \text{ GAL/YR} + 36270 \text{ GAL/YR} = \underline{510{,}360 \text{ GAL/YR}}$$

# CONSTRUCTION COST ESTIMATE

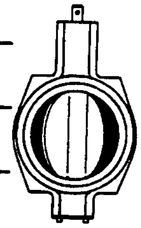
Project: Repair HTW Leaks in Valve Pits
Location: Fort Stewart, GA
Basis: Schematic Design
ECO No.: 7

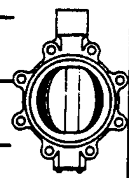
RS&H No.: 694-1331-002
Date: 02/14/96
Estimator: W.T.Todd
Filename: EST-7.WQ1

| ITEM DESCRIPTION | QUANTITY | | MATERIAL/EQUIP | | LABOR | | TOTAL COST | SOURCE | |
|---|---|---|---|---|---|---|---|---|---|
| | No. | Unit | $/Unit | Total | $/Unit | Total | | Material | Labor |
| Travel time to bldgs. | 2.2 | hr | | 0 | 30.3 | 66 | 66 | | (1) |
| Repair/tighten valves | 1.8 | hr | | 0 | 30.3 | 53 | 53 | | (2) |
| Repair/tighten flanges | 1.3 | hr | | 0 | 30.3 | 38 | 38 | | (3) |
| Remove valves (4) | 2 | Ea | | 0 | 217.8 | 436 | 436 | | MMp191 |
| 6" gate valve, 250 lb (4) | 2 | Ea | 700 | 1400 | 217.8 | 436 | 1,836 | MMp191 | MMp191 |
| Subtotal Bare Costs | | | | 1400 | | 1029 | $2,429 | | |
| Retrofit Cost Factors | | | 0% | 0 | 0% | 0 | 0 | MMp6 | MMp6 |
| Subtotal | | | | 1400 | | 1029 | 2,429 | | |
| City Cost Index (Sav. GA) | | | 0% | 0 | -44% | -455 | (455) | MMp533 | MMp533 |
| Subtotal | | | | 1400 | | 574 | 1,974 | | |
| OH & Profit Markups | | | 10% | 140 | 53% | 304 | 444 | MMp7 | MMp475 |
| Subtotal | | | | 1540 | | 878 | 2,418 | | |
| Sales Taxes | | | 4.0% | 62 | | NA | 62 | MMp476 | |
| Total Construction Cost | | | | 1602 | | 878 | 2,480 | | |
| Design Fee | | | | NA | 6.0% | 149 | 149 | | |
| SIOH | | | | NA | 6.0% | 149 | 149 | | |
| Subtotal | | | | 1602 | | 1176 | 2,778 | | |
| Contingency | | | 0% | 0 | 0% | 0 | 0 | MEp6 | MEp6 |
| Total Project Cost | | | | 1602 | | 1176 | $2,778 | | |

LEGEND:
(1) Estimate 10 minutes per valve pit for 13 valve pits.
(2) Estimate 15 minutes per valve for 7 valves (also see note 4).
(3) Estimate 15 minutes per flange for 5 flanges.
(4) Assumes 25 % of the 9 leaking valves will be replaced.
MMp### 1996 Means Mechanical Cost Data, page ###.

## 151 950 | Valves





| | | | CREW | DAILY OUTPUT | LABOR-HOURS | UNIT | 1996 BARE COSTS MAT. | LABOR | EQUIP. | TOTAL | TOTAL INCL O&P | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 960 | 1050 | 3" size R151-090 | Q-1 | 8 | 2 | Ea. | 175 | 54 | | 229 | 276 | 960 |
| | 1060 | 4" size | | 5 | 3.200 | | 215 | 86.50 | | 301.50 | 370 | |
| | 1070 | 5" size | Q-2 | 5 | 4.800 | | 250 | 135 | | 385 | 480 | |
| | 1080 | 6" size | | 5 | 4.800 | | 273 | 135 | | 408 | 505 | |
| | 1090 | 8" size | | 4.50 | 5.333 | | 360 | 150 | | 510 | 625 | |
| | 1100 | 10" size | | 4 | 6 | | 415 | 168 | | 583 | 715 | |
| | 1110 | 12" size | | 3 | 8 | | 570 | 224 | | 794 | 970 | |
| | 1200 | Lug type, lever actuator | | | | | | | | | | |
| | 1220 | 2" size | 1 Plum | 14 | .571 | Ea. | 87 | 17.15 | | 104.15 | 122 | |
| | 1230 | 2-1/2" size | Q-1 | 9 | 1.778 | | 89 | 48 | | 137 | 172 | |
| | 1240 | 3" size | | 8 | 2 | | 95 | 54 | | 149 | 188 | |
| | 1250 | 4" size | | 5 | 3.200 | | 121 | 86.50 | | 207.50 | 265 | |
| | 1260 | 5" size | Q-2 | 5 | 4.800 | | 175 | 135 | | 310 | 400 | |
| | 1270 | 6" size | | 5 | 4.800 | | 197 | 135 | | 332 | 425 | |
| | 1280 | 8" size | | 4.50 | 5.333 | | 281 | 150 | | 431 | 540 | |
| | 1290 | 10" size | | 4 | 6 | | 390 | 168 | | 558 | 690 | |
| | 1300 | 12" size | | 3 | 8 | | 595 | 224 | | 819 | 1,000 | |
| | 1320 | For gear actuator, add | | | | | 60% | | | | | |
| | 1400 | Diverter, 150 lb. flanged, bronze or iron plugs | | | | | | | | | | |
| | 1440 | 2" pipe size | Q-1 | 2 | 8 | Ea. | 2,475 | 216 | | 2,691 | 3,050 | |
| | 1450 | 3" pipe size | " | 1.50 | 10.667 | " | 3,550 | 289 | | 3,839 | 4,350 | |
| | 1650 | Gate, 125 lb., N.R.S., | | | | | | | | | | |
| | 2150 | Flanged | | | | | | | | | | |
| | 2200 | 2" size | 1 Plum | 5 | 1.600 | Ea. | 252 | 48 | | 300 | 350 | |
| | 2240 | 2-1/2" size | Q-1 | 5 | 3.200 | | 258 | 86.50 | | 344.50 | 415 | |
| | 2260 | 3" size | | 4.50 | 3.556 | | 290 | 96 | | 386 | 465 | |
| | 2280 | 4" size | | 3 | 5.333 | | 415 | 144 | | 559 | 675 | |
| | 2290 | 5" size | Q-2 | 3.40 | 7.059 | | 705 | 198 | | 903 | 1,075 | |
| | 2300 | 6" size | | 3 | 8 | | 705 | 224 | | 929 | 1,125 | |
| | 2320 | 8" size | | 2.50 | 9.600 | | 1,225 | 269 | | 1,494 | 1,750 | |
| | 2340 | 10" size | | 2.20 | 10.909 | | 2,150 | 305 | | 2,455 | 2,850 | |
| | 2360 | 12" size | | 1.70 | 14.118 | | 2,950 | 395 | | 3,345 | 3,850 | |
| | 2370 | 14" size | | 1.30 | 18.462 | | 3,575 | 520 | | 4,095 | 4,725 | |
| | 2380 | 16" size | | 1 | 24 | | 5,225 | 675 | | 5,900 | 6,775 | |
| | 2420 | For 250 lb., flanged, add | | | | | 200% | 10% | | | | |
| | 3550 | OS&Y, flanged | | | | | | | | | | |
| | 3600 | 2" size | 1 Plum | 5 | 1.600 | Ea. | 128 | 48 | | 176 | 215 | |
| | 3640 | 2-1/2" size | Q-1 | 5 | 3.200 | | 132 | 86.50 | | 218.50 | 277 | |
| | 3660 | 3" size | | 4.50 | 3.556 | | 149 | 96 | | 245 | 310 | |
| | 3670 | 3-1/2" size | | 3 | 5.333 | | 212 | 144 | | 356 | 455 | |
| | 3680 | 4" size | | 3 | 5.333 | | 212 | 144 | | 356 | 455 | |
| | 3690 | 5" size | Q-2 | 3.40 | 7.059 | | 350 | 198 | | 548 | 690 | |
| | 3700 | 6" size | | 3 | 8 | | 350 | 224 | | 574 | 730 | |
| | 3720 | 8" size | | 2.50 | 9.600 | | 625 | 269 | | 894 | 1,100 | |
| | 3740 | 10" size | | 2.20 | 10.909 | | 1,150 | 305 | | 1,455 | 1,750 | |
| | 3760 | 12" size | | 1.70 | 14.118 | | 1,525 | 395 | | 1,920 | 2,275 | |
| | 3770 | 14" size | | 1.30 | 18.462 | | 2,950 | 520 | | 3,470 | 4,050 | |
| | 3780 | 16" size | | 1 | 24 | | 4,575 | 675 | | 5,250 | 6,050 | |
| | 3790 | 18" size | | .80 | 30 | | 6,125 | 840 | | 6,965 | 8,050 | |
| | 3800 | 20" size | | .60 | 40 | | 8,550 | 1,125 | | 9,675 | 11,100 | |
| | 3830 | 24" size | | .50 | 48 | | 12,700 | 1,350 | | 14,050 | 16,100 | |
| | 3900 | For 250 lb flanged, add | | | | | 200% | 10% | | | | |
| | 4350 | Globe, OS&Y, | | | | | | | | | | |
| | 4540 | Class 125, flanged | | | | | | | | | | |
| | 4550 | 2" size | 1 Plum | 5 | 1.600 | Ea. | 266 | 48 | | 314 | 365 | |
| | 4560 | 2-1/2" size | Q-1 | 5 | 3.200 | | 281 | 86.50 | | 367.50 | 440 | |

MECHANICAL 15

A.3.7-10

# ECO NUMBER 8

## REPAIR UNDERGROUND HTW DISTRIBUTION SYSTEM LEAKS

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-08
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-8 REPAIR LEAKS IN UNDERGROUND HTW PIPING
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 04-16-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 127866. | | |
| B. SIOH | $ 0. | | |
| C. DESIGN COST | $ 0. | | |
| D. TOTAL COST (1A+1B+1C) | $ 127866. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 127866. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 4. | $ 59. | 15.08 | $ 897. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 3319. | $ 4448. | 14.88 | $ 66184. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 3324. | $ 4507. | | $ 67081. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 485.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 7217.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 7217.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 4992.

5. SIMPLE PAYBACK PERIOD (1G/4) 25.61 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 74298.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= .58
(IF < 1 PROJECT DOES NOT QUALIFY)

| | | | |
|---|---|---|---|
| **RS&H** SUBJECT | FORT STEWART REPAIR LEAKS IN HTW PIPING | AEP NO | 694 1331 002 |
| | | SHEET | OF |
| DESIGNER | W. TODD | DATE | 4/11/96 |
| CHECKER | | DATE | |

ECO - 8

The survey of valve pits indicated 28 sections of HTW piping with possible underground leaks. Based on the observed flow from the conduit vents, there are no large leaks in the system.

The leak locating tests were inconclusive. The background noise (flow, boiling, water hammer, etc.) was to great and the leaks are too small to obtain a good correlation. Shutting down the CEP and/or various HTW zones was discussed with the DPW staff, and it was decided that it was not a good idea to shut off the hospital and dining facilities to try and locate about 2 GPM of leaks.

ASSUMPTIONS

1) There is one small leak in each of the 28 sections of pipe identified during the survey.

2) The total flow of HTW from all of the leaks combined is about 1.66 gallons per minute.

3) All of the leaks can be found and repaired with three dig and cut operations per leak.

Note: Assumptions 1 and 3 are conservative estimates and can not be verified prior to the actual construction.

Energy and Cost Savings were calculated using a spreadsheet computer program. The calculations and results are shown on the following sheet.

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. | |
| AEP Number: | 694-1331-002 | Designer: | W. T. Todd |
| Project: | Existing Leaks in HTW Piping | Date: | 04/15/96 |
| ECO Number: | 8 | | |

Assumptions:

| | | |
|---|---|---|
| 1. HTW temperature | 380 | °F |
| 2. Make-up water temperature | 70 | °F |
| 3. Boiler efficiency | 68% | |
| 4. Pump head (from record drawings) | 300 | Ft H20 |
| 5. Pump efficiency (from record drawings | 72% | |
| 6. Motor efficiency | 90% | |
| 7. Average heating fuel cost | $1.34 | /MBtu |
| 8. Electricity cost | $0.0469 | /kWh |
| 9. Water cost | $0.5562 | /kGallons |

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

872496 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 2257.1 MBtu/Yr

Heating Fuel Use = 2257.1 MBtu/yr / 0.68 = 3319.3 MBtu/Yr

Heating Fuel Cost = 3319.3 MBtu/yr x $1.34 /MBtu = $4,448 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$BHP = \frac{1.66 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.175 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency ) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.175 BHP / 0.90 x 0.746 kW/HP = 0.145 kW

Electricity Use = 0.145 kW x 8760 Hr/Yr = 1268 kWh/Yr

Electricity Use = 1268 kWh/Yr x 0.003413 MBtu/kWh = 4.33 MBtu/Yr

Electricity Cost = 1268 kWh/Yr x $0.0469 /kWh = $59 /Year

Water Cost:

872496 Gal/Yr x $0.5562 /kGal = $485 /Year

Total Utility Cost:

| | | |
|---|---|---|
| Heating Fuel Cost | $4,448 | /Year |
| Pumping (Elec) Cost | $59 | /Year |
| Water Cost | $485 | /Year |
| Total Utility Cost | $4,992 | /Year |

RS&H

SUBJECT FORT STEWART
REPAIR HTW PIPING LEAKS
DESIGNER W. TODD
CHECKER

AEP NO 694-1331-002
SHEET ____ OF ____
DATE 4/11/96
DATE

| Valve Pit No. | No. of Conduit Vents w/Steam Flow |
|---|---|
| VP-1-4 | 2 |
| VP-1-10 | 1 |
| DP-1-13 | 1 |
| VP-1-13 | 1 |
| VP-1-14 | 1 |
| VP-1-16 | 1 |
| VP-1-17 | 1 |
| DP-1-17/18 | 1 |
| VP-1-18 | 1 |
| VP-2N-1 | 1 |
| VP-3-2 | 1 |
| VP-3-2A | 1 |
| VP-3-3 | 1 |
| VP-3-7 | 2 |
| VP-3-9 | 2 |
| VP-3-10 | 2 |
| VP-3-11 | 3 |
| VP-3-12 | 1 |
| VP-3-13A | 1 |
| VP-3-14 | 2 |
| VP-S-12 | 1 |
| Total | 28 |

# CONSTRUCTION COST ESTIMATE

| | | | |
|---|---|---|---|
| Project: | Repair HTW Piping Leaks | RS&H No.: | 694-1331-002 |
| Location: | Fort Stewart, GA | Date: | 04/16/96 |
| Basis: | Schematic Design | Estimator: | W.T.Todd |
| ECO Number: 8 | | Filename: | EST-8A.WB2 |

| | QUANTITY | | MATERIAL/EQUIP | | LABOR | | TOTAL | SOURCE | |
|---|---|---|---|---|---|---|---|---|---|
| ITEM DESCRIPTION | No. | Unit | $/Unit | Total | $/Unit | Total | COST | Material | Labor |
| Shut off HTW zone | 4 | MH | 0 | 0 | 30.30 | 121 | 121 | | MMp475 |
| Excavation, backhoe to 6' | 90 | CY | 1.43 | 129 | 1.82 | 164 | 293 | MMp28 | MMp28 |
| Excavation, by hand to 6' | 60 | CY | 0 | 0 | 29.65 | 1779 | 1,779 | MMp28 | MMp28 |
| Remove conduit, torch | 18 | LF | 1.06 | 19 | 4.95 | 89 | 108 | MMp22 | MMp22 |
| Remove pipe insulation | 6 | LF | 0 | 0 | 4.84 | 29 | 29 | | MMp236 |
| Valve off and drain pipe | 0.50 | MH | 0 | 0 | 30.30 | 15 | 15 | | MMp475 |
| Repair HTW leak - Weld | 1 | Ea | 1.95 | 2 | 16.05 | 16 | 18 | MMp144 | MMp144 |
| Open valves - fill pipe | 0.50 | Ea | 0 | 0 | 30.30 | 15 | 15 | | MMp475 |
| Replace pipe insulation | 6 | LF | 0 | 0 | 4.84 | 29 | 29 | | MMp236 |
| Weld conduit, 24" Sch 40 | 3 | Ea | 35 | 105 | 289 | 867 | 972 | MMp144 | MMp144 |
| Backfill trench, by hand | 60 | CY | | 0 | 12.85 | 771 | 771 | MMp28 | MMp28 |
| Compact backfill, by hand | 60 | CY | | 0 | 4.66 | 280 | 280 | MMp28 | MMp28 |
| Backfill trench, dozer | 90 | CY | 0.95 | 86 | 0.32 | 29 | 115 | MMp28 | MMp28 |
| Compact backfill, dozer | 90 | CY | 1.37 | 123 | 0.41 | 37 | 160 | MMp28 | MMp28 |
| Total Cost per Leak | | | | 464 | | 4241 | 4,705 | | |
| Total Cost for All Leaks | 28 | Ea | 464 | 12992 | 4241 | 118748 | 131,740 | | |
| Subtotal Bare Costs | | | | 12992 | | 118748 | $131,740 | | |
| Retrofit Cost Factors | | | 0% | 0 | 0% | 0 | 0 | MMp6 | MMp6 |
| Subtotal | | | | 12992 | | 118748 | 131,740 | | |
| City Cost Index (Sav. GA) | | | 0% | 0 | -44% | -52487 | (52,487) | MMp533 | MMp533 |
| Subtotal | | | | 12992 | | 66261 | 79,253 | | |
| OH & Profit Markups | | | 10% | 1299 | 53% | 35118 | 36,417 | MMp7 | MMp475 |
| Subtotal | | | | 14291 | | 101379 | 115,670 | | |
| Sales Taxes | | | 4.0% | 572 | | NA | 572 | MMp476 | |
| Subtotal | | | | 14863 | | 101379 | 116,242 | | |
| Contingency | | | 10% | 1486 | 10% | 10138 | 11,624 | MEp6 | MEp6 |
| Total Construction Cost | | | | 16349 | | 111517 | 127,866 | | |
| Design Fee | | | | NA | 0.0% | 0 | 0 | | |
| SIOH | | | | NA | 0.0% | 0 | 0 | | |
| Total Project Cost | | | | 16349 | | 111517 | $127,866 | | |

LEGEND:
- MEp### 1996 Means Electrical Cost Data, page ###.
- MMp### 1996 Means Mechanical Cost Data, page ###.

**RS&H**®

# Telephone Call Confirmation

Project Number 694 1331 002

Local ______ L.D. ______ Placed B. Todd Rec'd ______ Date 4/11/96

Conversed with Gene Smith Of Fort Stewart DPW (912) 767-2138

Regarding Leak Repair of HTW Piping

Current leak repair method:

- Make an educated guess at where to start digging based on flow from valve pits and dig up trench.
- Remove (with cutting torch) a piece of conduit and look for leak. If not there, check direction of water flow in conduit and make another guess as to where to dig. Reweld conduit.
- Repeat above steps until leak is found. The leak is typically only about 1/4" in diameter and they can weld it shut.

Distribution:

# Installing Contractor's Overhead & Profit

Below are the **average** installing contractor's percentage mark-ups applied to base labor rates to arrive at typical billing rates.

**Column A:** Labor rates are based on union wages averaged for 30 major U.S. cities. Base rates including fringe benefits are listed hourly and daily. These figures are the sum of the wage rate and employer-paid fringe benefits such as vacation pay, employer-paid health and welfare costs, pension costs, plus appropriate training and industry advancement funds costs.

**Column B:** Workers' Compensation rates are the national average of state rates established for each trade.

**Column C:** Column C lists average fixed overhead figures for all trades. Included are Federal and State Unemployment costs set at 7.3%; Social Security Taxes (FICA) set at 7.65%; Builder's Risk Insurance costs set at 0.34%; and Public Liability costs set at 1.55%. All the percentages except those for Social Security Taxes vary from state to state as well as from company to company.

**Columns D and E:** Percentages in Columns D and E are based on the presumption that the installing contractor has annual billing of $500,000 and up. Overhead percentages may increase with smaller annual billing. The overhead percentages for any given contractor may vary greatly and depend on a number of factors, such as the contractor's annual volume, engineering and logistical support costs, and staff requirements. The figures for overhead and profit will also vary depending on the type of job, the job location, and the prevailing economic conditions. All factors should be examined very carefully for each job.

**Column F:** Column F lists the total of Columns B, C, D, and E.

**Column G:** Column G is Column A (hourly base labor rate) multiplied by the percentage in Column F (O&P percentage).

**Column H:** Column H is the total of Column A (hourly base labor rate) plus Column G (Total O&P).

**Column I:** Column I is Column H multiplied by eight hours.

| | | A | | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Base Rate Incl. Fringes | | Workers' Comp. Ins. | Average Fixed Overhead | Overhead | Profit | Total Overhead & Profit | | Rate with O & P | |
| Abbr. | Trade | Hourly | Daily | | | | | % | Amount | Hourly | Daily |
| Skwk | Skilled Workers Average (35 trades) | $25.95 | $207.60 | 20.2% | 16.8% | 13.0% | 10% | 60.0% | $15.55 | $41.50 | $332.00 |
| | Helpers Average (5 trades) | 19.25 | 154.00 | 21.4 | | 11.0 | | 59.2 | 11.40 | 30.65 | 245.20 |
| | Foreman Average, Inside ($.50 over trade) | 26.45 | 211.60 | 20.2 | | 13.0 | | 60.0 | 15.85 | 42.30 | 338.40 |
| | Foreman Average, Outside ($2.00 over trade) | 27.95 | 223.60 | 20.2 | | 13.0 | | 60.0 | 16.75 | 44.70 | 357.60 |
| Clab | Common Building Laborers | 19.80 | 158.40 | 21.9 | | 11.0 | | 59.7 | 11.80 | 31.60 | 252.80 |
| Asbe | Asbestos Workers | 28.55 | 228.40 | 19.7 | | 16.0 | | 62.5 | 17.85 | 46.40 | 371.20 |
| Boil | Boilermakers | 30.05 | 240.40 | 17.7 | | 16.0 | | 60.5 | 18.20 | 48.25 | 386.00 |
| Bric | Bricklayers | 25.90 | 207.20 | 19.4 | | 11.0 | | 57.2 | 14.80 | 40.70 | 325.60 |
| Brhe | Bricklayer Helpers | 20.00 | 160.00 | 19.4 | | 11.0 | | 57.2 | 11.45 | 31.45 | 251.60 |
| Carp | Carpenters | 25.20 | 201.60 | 21.9 | | 11.0 | | 59.7 | 15.05 | 40.25 | 322.00 |
| Cefi | Cement Finishers | 24.35 | 194.80 | 12.8 | | 11.0 | | 50.6 | 12.30 | 36.65 | 293.20 |
| Elec | Electricians | 29.30 | 234.40 | 8.0 | | 16.0 | | 50.8 | 14.90 | 44.20 | 353.60 |
| Elev | Elevator Constructors | 30.05 | 240.40 | 9.6 | | 16.0 | | 52.4 | 15.75 | 45.80 | 366.40 |
| Eqhv | Equipment Operators, Crane or Shovel | 26.75 | 214.00 | 12.9 | | 14.0 | | 53.7 | 14.35 | 41.10 | 328.80 |
| Eqmd | Equipment Operators, Medium Equipment | 25.70 | 205.60 | 12.9 | | 14.0 | | 53.7 | 13.80 | 39.50 | 316.00 |
| Eqlt | Equipment Operators, Light Equipment | 24.70 | 197.60 | 12.9 | | 14.0 | | 53.7 | 13.25 | 37.95 | 303.60 |
| Eqol | Equipment Operators, Oilers | 21.90 | 175.20 | 12.9 | | 14.0 | | 53.7 | 11.75 | 33.65 | 269.20 |
| Eqmm | Equipment Operators, Master Mechanics | 27.55 | 220.40 | 12.9 | | 14.0 | | 53.7 | 14.80 | 42.35 | 338.80 |
| Glaz | Glaziers | 24.90 | 199.20 | 16.0 | | 11.0 | | 53.8 | 13.40 | 38.30 | 306.40 |
| Lath | Lathers | 24.95 | 199.60 | 13.5 | | 11.0 | | 51.3 | 12.80 | 37.75 | 302.00 |
| Marb | Marble Setters | 25.65 | 205.20 | 19.4 | | 11.0 | | 57.2 | 14.65 | 40.30 | 322.40 |
| Mill | Millwrights | 26.55 | 212.40 | 13.2 | | 11.0 | | 51.0 | 13.55 | 40.10 | 320.80 |
| Mstz | Mosaic & Terrazzo Workers | 25.25 | 202.00 | 11.0 | | 11.0 | | 48.8 | 12.30 | 37.55 | 300.40 |
| Pord | Painters, Ordinary | 22.95 | 183.60 | 16.8 | | 11.0 | | 54.6 | 12.55 | 35.50 | 284.00 |
| Psst | Painters, Structural Steel | 23.95 | 191.60 | 62.5 | | 11.0 | | 100.3 | 24.00 | 47.95 | 383.60 |
| Pape | Paper Hangers | 23.30 | 186.40 | 16.8 | | 11.0 | | 54.6 | 12.70 | 36.00 | 288.00 |
| Pile | Pile Drivers | 25.35 | 202.80 | 33.6 | | 16.0 | | 76.4 | 19.35 | 44.70 | 357.60 |
| Plas | Plasterers | 24.20 | 193.60 | 17.4 | | 11.0 | | 55.2 | 13.35 | 37.55 | 300.40 |
| Plah | Plasterer Helpers | 20.15 | 161.20 | 17.4 | | 11.0 | | 55.2 | 11.10 | 31.25 | 250.00 |
| Plum | Plumbers | 30.05 | 240.40 | 10.2 | | 16.0 | | 53.0 | 15.95 | 46.00 | 368.00 |
| Rodm | Rodmen (Reinforcing) | 27.75 | 222.00 | 36.3 | | 14.0 | | 77.1 | 21.40 | 49.15 | 393.20 |
| Rofc | Roofers, Composition | 22.55 | 180.40 | 37.4 | | 11.0 | | 75.2 | 16.95 | 39.50 | 316.00 |
| Rots | Roofers, Tile & Slate | 22.60 | 180.80 | 37.4 | | 11.0 | | 75.2 | 17.00 | 39.60 | 316.80 |
| Rohe | Roofers, Helpers (Composition) | 15.95 | 127.60 | 37.4 | | 11.0 | | 75.2 | 12.00 | 27.95 | 223.60 |
| Shee | Sheet Metal Workers | 28.95 | 231.60 | 13.8 | | 16.0 | | 56.6 | 16.40 | 45.35 | 362.80 |
| Spri | Sprinkler Installers | 31.30 | 250.40 | 10.4 | | 16.0 | | 53.2 | 16.65 | 47.95 | 383.60 |
| Stpi | Steamfitters or Pipefitters | 30.30 | 242.40 | 10.2 | | 16.0 | | 53.0 | 16.05 | 46.35 | 370.80 |
| Ston | Stone Masons | 25.90 | 207.20 | 19.4 | | 11.0 | | 57.2 | 14.80 | 40.70 | 325.60 |
| Sswk | Structural Steel Workers | 27.85 | 222.80 | 46.4 | | 14.0 | | 87.2 | 24.30 | 52.15 | 417.20 |
| Tilf | Tile Layers | 25.05 | 200.40 | 11.0 | | 11.0 | | 48.8 | 12.20 | 37.25 | 298.00 |
| Tilh | Tile Layers Helpers | 20.30 | 162.40 | 11.0 | | 11.0 | | 48.8 | 9.90 | 30.20 | 241.60 |
| Trlt | Truck Drivers, Light | 20.35 | 162.80 | 17.0 | | 11.0 | | 54.8 | 11.15 | 31.50 | 252.00 |
| Trhv | Truck Drivers, Heavy | 20.70 | 165.60 | 17.0 | | 11.0 | | 54.8 | 11.35 | 32.05 | 256.40 |
| Sswl | Welders, Structural Steel | 27.85 | 222.80 | 46.4 | | 14.0 | | 87.2 | 24.30 | 52.15 | 417.20 |
| Wrck | *Wrecking | 19.80 | 158.40 | 44.8 | | 11.0 | | 82.6 | 16.35 | 36.15 | 289.20 |

*Not included in Averages.

# City Cost Indexes

| | DIVISION | FLORIDA | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MIAMI | | | ORLANDO | | | PANAMA CITY | | | PENSACOLA | | | ST. PETERSBURG | | | TALLAHASSEE | | |
| | | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL |
| 2 | SITE WORK | 110.3 | 72.8 | 81.5 | 125.3 | 85.9 | 95.0 | 141.6 | 83.4 | 96.9 | 138.9 | 85.9 | 98.1 | 126.2 | 85.6 | 95.0 | 125.7 | 85.2 | 94.6 |
| 031 | CONCRETE FORMWORK | 94.2 | 71.0 | 74.5 | 97.3 | 71.6 | 75.5 | 95.8 | 37.8 | 46.6 | 84.5 | 69.7 | 72.0 | 94.1 | 64.8 | 69.3 | 97.3 | 53.0 | 59.7 |
| 032 | CONCRETE REINFORCEMENT | 95.1 | 72.5 | 82.4 | 95.1 | 79.0 | 86.0 | 99.3 | 64.5 | 79.7 | 101.5 | 64.9 | 81.0 | 98.5 | 74.3 | 84.9 | 95.1 | 65.2 | 78.3 |
| 033 | CAST IN PLACE CONCRETE | 91.5 | 75.4 | 84.6 | 88.7 | 78.0 | 84.1 | 95.2 | 43.0 | 72.9 | 95.2 | 69.0 | 84.0 | 101.4 | 70.2 | 88.1 | 91.7 | 58.4 | 77.5 |
| 3 | CONCRETE | 87.4 | 74.3 | 80.8 | 86.3 | 76.7 | 81.4 | 95.0 | 46.6 | 70.5 | 93.5 | 70.1 | 81.7 | 92.6 | 70.1 | 81.2 | 87.7 | 59.2 | 73.3 |
| 4 | MASONRY | 76.9 | 70.2 | 72.8 | 77.4 | 75.6 | 76.2 | 84.9 | 37.4 | 55.4 | 82.6 | 67.6 | 73.3 | 119.2 | 66.9 | 86.7 | 83.6 | 52.6 | 64.4 |
| 5 | METALS | 98.8 | 93.5 | 96.8 | 107.9 | 95.0 | 103.0 | 97.2 | 75.1 | 88.9 | 97.1 | 89.6 | 94.3 | 101.0 | 92.4 | 97.7 | 99.2 | 88.1 | 95.0 |
| 6 | WOOD & PLASTICS | 88.6 | 72.7 | 80.6 | 94.5 | 71.1 | 82.8 | 92.9 | 38.3 | 65.6 | 80.1 | 71.1 | 75.6 | 90.8 | 65.2 | 78.0 | 94.5 | 51.6 | 73.0 |
| 7 | THERMAL & MOISTURE PROTECTION | 99.6 | 74.6 | 88.0 | 96.6 | 75.6 | 86.9 | 96.9 | 38.3 | 69.9 | 96.6 | 66.9 | 82.9 | 96.3 | 63.1 | 81.0 | 96.6 | 58.8 | 79.1 |
| 8 | DOORS & WINDOWS | 95.9 | 69.5 | 89.5 | 98.1 | 68.2 | 90.9 | 95.7 | 35.2 | 81.2 | 95.7 | 66.5 | 88.7 | 96.8 | 60.4 | 88.0 | 98.1 | 53.9 | 87.4 |
| 092 | LATH, PLASTER & GYPSUM BOARD | 101.0 | 72.5 | 82.5 | 101.6 | 70.8 | 81.7 | 99.7 | 36.9 | 59.0 | 94.5 | 70.9 | 79.2 | 98.9 | 64.8 | 76.8 | 101.6 | 50.7 | 68.6 |
| 095 | ACOUSTICAL TREATMENT & WOOD FLOORING | 102.4 | 72.5 | 83.0 | 102.4 | 70.8 | 82.0 | 96.6 | 36.9 | 58.0 | 96.6 | 70.9 | 79.9 | 98.0 | 64.8 | 76.5 | 102.4 | 50.7 | 68.9 |
| 096 | FLOORING & CARPET | 121.8 | 75.3 | 110.7 | 113.0 | 74.9 | 103.8 | 112.3 | 24.6 | 91.3 | 106.7 | 68.0 | 97.4 | 111.4 | 67.8 | 100.9 | 113.0 | 49.7 | 97.8 |
| 099 | PAINTING & WALL COVERINGS | 100.9 | 70.1 | 83.0 | 104.2 | 77.6 | 88.7 | 104.2 | 34.5 | 63.7 | 104.2 | 78.5 | 89.3 | 104.2 | 65.4 | 81.6 | 104.2 | 55.7 | 76.0 |
| 9 | FINISHES | 108.6 | 71.4 | 89.7 | 107.7 | 72.7 | 89.9 | 107.2 | 34.4 | 70.2 | 104.5 | 70.5 | 87.2 | 106.0 | 65.3 | 85.3 | 107.7 | 51.9 | 79.3 |
| 10-14 | TOTAL DIV. 10-14 | 100.0 | 81.8 | 96.1 | 100.0 | 83.9 | 96.6 | 100.0 | 65.4 | 92.6 | 100.0 | 73.3 | 94.3 | 100.0 | 76.8 | 95.1 | 100.0 | 74.0 | 94.5 |
| 15 | MECHANICAL | 100.0 | 72.9 | 88.0 | 100.0 | 70.8 | 87.1 | 100.0 | 34.6 | 71.1 | 100.0 | 68.8 | 86.2 | 100.0 | 68.7 | 86.2 | 100.0 | 54.8 | 80.0 |
| 16 | ELECTRICAL | 98.0 | 84.9 | 89.3 | 98.0 | 63.0 | 74.6 | 96.3 | 47.1 | 63.5 | 101.8 | 63.4 | 76.2 | 98.5 | 68.1 | 78.2 | 98.0 | 58.3 | 71.5 |
| 1-16 | WEIGHTED AVERAGE | 97.5 | 76.7 | 87.4 | 99.2 | 75.1 | 87.6 | 99.2 | 48.1 | 74.5 | 98.8 | 71.8 | 85.7 | 101.0 | 71.8 | 86.9 | 98.5 | 62.1 | 80.9 |

| | DIVISION | FLORIDA | | | GEORGIA | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | TAMPA | | | ALBANY | | | ATLANTA | | | AUGUSTA | | | COLUMBUS | | | MACON | | |
| | | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL |
| 2 | SITE WORK | 126.9 | 85.6 | 95.1 | 110.4 | 74.2 | 82.5 | 114.3 | 92.8 | 97.8 | 110.2 | 91.5 | 95.8 | 110.4 | 74.3 | 82.6 | 111.6 | 91.9 | 96.5 |
| 031 | CONCRETE FORMWORK | 97.3 | 64.9 | 69.8 | 96.9 | 50.8 | 57.8 | 98.0 | 70.3 | 74.5 | 94.5 | 61.8 | 66.7 | 96.9 | 50.4 | 57.4 | 95.9 | 65.9 | 70.5 |
| 032 | CONCRETE REINFORCEMENT | 95.1 | 74.3 | 83.4 | 95.1 | 76.4 | 84.6 | 98.5 | 77.5 | 86.7 | 104.0 | 69.1 | 84.4 | 95.1 | 76.4 | 84.6 | 97.4 | 76.7 | 85.8 |
| 033 | CAST IN PLACE CONCRETE | 101.7 | 70.2 | 88.2 | 95.5 | 48.9 | 75.6 | 101.1 | 71.2 | 88.3 | 95.6 | 57.9 | 79.5 | 95.5 | 49.5 | 75.8 | 95.5 | 53.3 | 77.5 |
| 3 | CONCRETE | 92.4 | 70.2 | 81.2 | 89.4 | 57.0 | 73.0 | 94.0 | 72.1 | 82.9 | 90.5 | 62.2 | 76.2 | 89.4 | 57.0 | 73.0 | 89.7 | 65.1 | 77.3 |
| 4 | MASONRY | 82.8 | 66.9 | 72.9 | 83.4 | 38.9 | 55.7 | 92.1 | 63.6 | 74.4 | 92.2 | 49.1 | 65.4 | 83.4 | 39.3 | 56.0 | 98.6 | 46.7 | 66.4 |
| 5 | METALS | 102.2 | 92.4 | 98.5 | 96.8 | 89.0 | 93.9 | 93.7 | 74.5 | 86.4 | 92.4 | 69.4 | 83.7 | 96.7 | 89.3 | 93.9 | 91.7 | 90.1 | 91.1 |
| 6 | WOOD & PLASTICS | 94.5 | 65.2 | 79.8 | 93.7 | 51.6 | 72.6 | 99.7 | 72.2 | 86.0 | 95.9 | 64.6 | 80.3 | 93.7 | 51.3 | 72.5 | 97.4 | 69.9 | 83.6 |
| 7 | THERMAL & MOISTURE PROTECTION | 96.6 | 64.3 | 81.7 | 96.4 | 55.7 | 77.6 | 94.2 | 70.0 | 83.0 | 93.6 | 59.5 | 77.9 | 96.1 | 55.7 | 77.5 | 95.1 | 62.9 | 80.2 |
| 8 | DOORS & WINDOWS | 98.1 | 60.4 | 89.0 | 95.9 | 53.7 | 85.7 | 94.2 | 67.9 | 87.9 | 90.6 | 59.3 | 83.1 | 95.9 | 53.8 | 85.7 | 94.2 | 64.8 | 87.1 |
| 092 | LATH, PLASTER & GYPSUM BOARD | 101.6 | 64.8 | 77.7 | 101.6 | 50.7 | 68.6 | 112.5 | 72.0 | 86.2 | 111.3 | 64.1 | 80.7 | 101.6 | 50.4 | 68.4 | 108.3 | 69.5 | 83.2 |
| 095 | ACOUSTICAL TREATMENT & WOOD FLOORING | 102.4 | 64.8 | 78.1 | 102.4 | 50.7 | 69.0 | 108.7 | 72.0 | 84.9 | 108.7 | 64.1 | 79.8 | 102.4 | 50.4 | 68.7 | 95.9 | 69.5 | 78.8 |
| 096 | FLOORING & CARPET | 113.0 | 67.8 | 102.1 | 113.0 | 40.4 | 95.6 | 87.8 | 75.0 | 84.8 | 86.7 | 51.5 | 78.2 | 113.0 | 41.0 | 95.7 | 87.8 | 47.5 | 78.2 |
| 099 | PAINTING & WALL COVERINGS | 104.2 | 65.4 | 81.6 | 100.9 | 50.4 | 71.5 | 99.0 | 72.1 | 83.4 | 99.0 | 47.9 | 69.3 | 100.9 | 48.3 | 70.3 | 102.4 | 59.0 | 77.2 |
| 9 | FINISHES | 107.7 | 65.3 | 86.1 | 105.8 | 48.1 | 76.4 | 95.1 | 71.5 | 83.1 | 94.4 | 58.6 | 76.1 | 105.7 | 47.8 | 76.2 | 91.5 | 62.0 | 76.5 |
| 10-14 | TOTAL DIV. 10-14 | 100.0 | 76.8 | 95.1 | 100.0 | 69.5 | 93.5 | 100.0 | 75.4 | 94.8 | 100.0 | 71.0 | 93.8 | 100.0 | 69.4 | 93.5 | 100.0 | 73.6 | 94.4 |
| 15 | MECHANICAL | 100.0 | 68.7 | 86.2 | 100.0 | 56.8 | 80.9 | 100.1 | 71.7 | 87.5 | 100.1 | 54.0 | 79.7 | 100.0 | 46.2 | 76.2 | 100.0 | 52.1 | 78.8 |
| 16 | ELECTRICAL | 97.5 | 68.1 | 77.9 | 93.3 | 68.1 | 76.5 | 93.4 | 82.3 | 86.0 | 96.9 | 61.3 | 73.2 | 93.3 | 49.4 | 64.0 | 91.4 | 63.3 | 72.7 |
| 1-16 | WEIGHTED AVERAGE | 99.5 | 71.8 | 86.1 | 97.1 | 60.8 | 79.5 | 96.5 | 75.0 | 86.1 | 95.5 | 62.5 | 79.5 | 97.1 | 55.7 | 77.1 | 95.4 | 65.4 | 80.9 |

| | DIVISION | GEORGIA | | | | | | HAWAII | | | IDAHO | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SAVANNAH | | | VALDOSTA | | | HONOLULU | | | BOISE | | | LEWISTON | | | POCATELLO | | |
| | | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL |
| 2 | SITE WORK | 110.6 | 76.1 | 84.0 | 122.0 | 74.5 | 85.5 | 115.0 | 112.0 | 112.7 | 86.4 | 99.3 | 96.3 | 90.4 | 92.7 | 92.2 | 89.1 | 99.3 | 96.9 |
| 031 | CONCRETE FORMWORK | 97.0 | 60.5 | 66.0 | 80.8 | 51.9 | 56.3 | 102.1 | 158.7 | 150.1 | 97.4 | 89.3 | 90.5 | 106.3 | 87.1 | 90.0 | 97.4 | 89.3 | 90.5 |
| 032 | CONCRETE REINFORCEMENT | 100.7 | 69.5 | 83.2 | 100.8 | 50.3 | 72.5 | 109.9 | 125.0 | 118.4 | 96.0 | 78.4 | 86.1 | 108.6 | 96.1 | 101.6 | 96.3 | 78.5 | 86.3 |
| 033 | CAST IN PLACE CONCRETE | 91.5 | 56.6 | 76.6 | 93.0 | 57.4 | 77.8 | 170.2 | 127.7 | 152.0 | 98.6 | 93.8 | 96.6 | 107.8 | 93.9 | 101.8 | 99.6 | 93.8 | 97.1 |
| 3 | CONCRETE | 88.3 | 62.5 | 75.3 | 92.8 | 55.5 | 74.0 | 153.0 | 139.4 | 146.1 | 103.2 | 88.7 | 95.9 | 115.5 | 91.0 | 103.1 | 103.7 | 88.6 | 96.1 |
| 4 | MASONRY | 86.9 | 57.6 | 68.7 | 89.8 | 50.6 | 65.4 | 131.3 | 134.3 | 133.2 | 131.8 | 81.0 | 100.2 | 128.8 | 96.6 | 108.8 | 136.3 | 82.7 | 103.0 |
| 5 | METALS | 97.1 | 87.6 | 93.5 | 96.5 | 80.7 | 90.6 | 117.4 | 107.6 | 113.7 | 112.9 | 82.2 | 101.3 | 96.2 | 90.7 | 94.1 | 112.5 | 82.2 | 101.1 |
| 6 | WOOD & PLASTICS | 93.8 | 60.9 | 77.3 | 76.0 | 50.3 | 63.1 | 100.6 | 165.6 | 133.1 | 95.1 | 88.5 | 91.8 | 98.7 | 83.6 | 91.2 | 95.1 | 88.5 | 91.8 |
| 7 | THERMAL & MOISTURE PROTECTION | 96.4 | 59.2 | 79.3 | 96.1 | 60.0 | 79.5 | 109.5 | 133.7 | 120.6 | 97.9 | 84.0 | 91.5 | 167.6 | 89.8 | 131.7 | 98.0 | 83.8 | 91.5 |
| 8 | DOORS & WINDOWS | 95.9 | 56.7 | 86.4 | 91.4 | 46.3 | 80.5 | 110.6 | 146.5 | 119.2 | 94.9 | 81.7 | 91.7 | 116.3 | 85.0 | 108.7 | 94.9 | 78.5 | 91.0 |
| 092 | LATH, PLASTER & GYPSUM BOARD | 101.6 | 60.4 | 74.9 | 93.7 | 49.4 | 65.0 | 95.7 | 167.7 | 142.3 | 89.0 | 87.9 | 88.3 | 135.3 | 83.0 | 101.4 | 89.0 | 87.9 | 88.3 |
| 095 | ACOUSTICAL TREATMENT & WOOD FLOORING | 102.4 | 60.4 | 75.2 | 98.0 | 49.4 | 66.5 | 132.8 | 167.7 | 155.4 | 96.2 | 87.9 | 90.8 | 144.9 | 83.0 | 104.8 | 96.2 | 87.9 | 90.8 |
| 096 | FLOORING & CARPET | 113.0 | 60.7 | 100.4 | 105.1 | 48.5 | 91.5 | 127.8 | 128.3 | 127.9 | 97.5 | 74.8 | 92.1 | 135.1 | 97.9 | 126.2 | 97.5 | 74.8 | 92.1 |
| 099 | PAINTING & WALL COVERINGS | 100.9 | 59.9 | 77.0 | 100.9 | 43.7 | 67.6 | 123.8 | 148.0 | 137.9 | 109.4 | 67.9 | 85.2 | 134.4 | 91.3 | 109.3 | 109.4 | 78.2 | 91.3 |
| 9 | FINISHES | 105.8 | 60.5 | 82.8 | 101.9 | 50.0 | 75.5 | 124.5 | 153.9 | 139.5 | 93.2 | 84.6 | 88.8 | 156.4 | 89.0 | 122.1 | 93.2 | 85.8 | 89.4 |
| 10-14 | TOTAL DIV. 10-14 | 100.0 | 71.7 | 94.0 | 100.0 | 70.1 | 93.7 | 100.0 | 129.2 | 106.2 | 100.0 | 86.1 | 97.0 | 100.0 | 100.6 | 100.1 | 100.0 | 86.1 | 97.0 |
| 15 | MECHANICAL | 100.0 | 55.8 | 80.5 | 100.0 | 48.7 | 77.3 | 100.1 | 119.4 | 108.6 | 99.8 | 85.6 | 93.5 | 100.6 | 94.1 | 97.7 | 99.8 | 85.6 | 93.5 |
| 16 | ELECTRICAL | 93.3 | 65.4 | 74.7 | 90.2 | 40.8 | 57.2 | 109.7 | 128.8 | 122.5 | 85.2 | 78.7 | 80.9 | 87.5 | 92.2 | 90.6 | 85.7 | 79.4 | 81.5 |
| 1-16 | WEIGHTED AVERAGE | 97.2 | 64.6 | 81.4 | 96.8 | 55.0 | 76.6 | 115.9 | 129.5 | 122.5 | 101.0 | 85.2 | 93.4 | 111.9 | 92.1 | 102.3 | 101.3 | 85.5 | 93.7 |

COST INDEXES

A.3.8-9

W/LEAK LOCATOR

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-08
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-8 REPAIR LEAKS IN UNDERGROUND HTW PIPING
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 04-16-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 53511. | | |
| B. SIOH | $ 3211. | | |
| C. DESIGN COST | $ 3211. | | |
| D. TOTAL COST (1A+1B+1C) | $ 59933. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 59933. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 4. | $ 59. | 15.08 | $ 897. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 3319. | $ 4448. | 14.88 | $ 66184. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 3324. | $ 4507. | | $ 67081. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 485.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 7217.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 7217.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 4992.

5. SIMPLE PAYBACK PERIOD (1G/4) 12.00 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 74298.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.24
(IF < 1 PROJECT DOES NOT QUALIFY)

W/LEAK LOCATOR

# CONSTRUCTION COST ESTIMATE

Project: Repair HTW Piping Leaks
Location: Fort Stewart, GA
Basis: Schematic Design
ECO Number: 8

RS&H No.: 694-1331-002
Date: 04/15/96
Estimator: W.T.Todd
Filename: EST-8.WB2

| ITEM DESCRIPTION | QUANTITY No. | QUANTITY Unit | MATERIAL/EQUIP $/Unit | MATERIAL/EQUIP Total | LABOR $/Unit | LABOR Total | TOTAL COST | SOURCE Material | SOURCE Labor |
|---|---|---|---|---|---|---|---|---|---|
| Shut off HTW zone | 4 | MH | 0 | 0 | 30.30 | 121 | 121 | | MMp475 |
| Perform leak locator test | 1 | Ea | 0 | 0 | 300 | 300 | 300 | | Vendor |
| Excavation, backhoe to 6' | 30 | CY | 1.43 | 43 | 1.82 | 55 | 98 | MMp28 | MMp28 |
| Excavation, by hand to 6' | 20 | CY | 0 | 0 | 29.65 | 593 | 593 | MMp28 | MMp28 |
| Remove conduit, torch | 6 | LF | 1.06 | 6 | 4.95 | 30 | 36 | MMp22 | MMp22 |
| Remove pipe insulation | 2 | LF | 0 | 0 | 4.84 | 10 | 10 | | MMp236 |
| Valve off and drain pipe | 0.50 | MH | 0 | 0 | 30.30 | 15 | 15 | | MMp475 |
| Repair HTW leak - Weld | 1 | Ea | 1.95 | 2 | 16.05 | 16 | 18 | MMp144 | MMp144 |
| Open valves - fill pipe | 0.50 | Ea | 0 | 0 | 30.30 | 15 | 15 | | MMp475 |
| Replace pipe insulation | 2 | LF | 0 | 0 | 4.84 | 10 | 10 | | MMp236 |
| Weld conduit, 24" Sch 40 | 1 | Ea | 35 | 35 | 289 | 289 | 324 | MMp144 | MMp144 |
| Backfill trench, by hand | 20 | CY | | 0 | 12.85 | 257 | 257 | MMp28 | MMp28 |
| Compact backfill, by hand | 20 | CY | | 0 | 4.66 | 93 | 93 | MMp28 | MMp28 |
| Backfill trench, dozer | 30 | CY | 0.95 | 29 | 0.32 | 10 | 39 | MMp28 | MMp28 |
| Compact backfill, dozer | 30 | CY | 1.37 | 41 | 0.41 | 12 | 53 | MMp28 | MMp28 |
| Total Cost per Leak | | | | 156 | | 1826 | 1,982 | | |
| Total Cost for All Leaks | 28 | Ea | 156 | 4368 | 1826 | 51128 | 55,496 | | |
| Subtotal Bare Costs | | | | 4368 | | 51128 | $55,496 | | |
| Retrofit Cost Factors | | | 0% | 0 | 0% | 0 | 0 | MMp6 | MMp6 |
| Subtotal | | | | 4368 | | 51128 | 55,496 | | |
| City Cost Index (Sav. GA) | | | 0% | 0 | -44% | -22599 | (22,599) | MMp533 | MMp533 |
| Subtotal | | | | 4368 | | 28529 | 32,897 | | |
| OH & Profit Markups | | | 10% | 437 | 53% | 15120 | 15,557 | MMp7 | MMp475 |
| Subtotal | | | | 4805 | | 43649 | 48,454 | | |
| Sales Taxes | | | 4.0% | 192 | | NA | 192 | MMp476 | |
| Subtotal | | | | 4997 | | 43649 | 48,646 | | |
| Contingency | | | 10% | 500 | 10% | 4365 | 4,865 | MEp6 | MEp6 |
| Total Construction Cost | | | | 5497 | | 48014 | 53,511 | | |
| Design Fee | | | | NA | 6.0% | 3211 | 3,211 | | |
| SIOH | | | | NA | 6.0% | 3211 | 3,211 | | |
| Total Project Cost | | | | 5497 | | 54436 | $59,933 | | |

LEGEND:
- MEp### 1996 Means Electrical Cost Data, page ###.
- MMp### 1996 Means Mechanical Cost Data, page ###.

## ECO NUMBER 9

## REDUCE OR ELIMINATE HTW DISCHARGE DURING SEP START-UP

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-9
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-9 REDUCE HTW LOSSES DURING SEP START-UP
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT
A. CONSTRUCTION COST $ 0.
B. SIOH $ 0.
C. DESIGN COST $ 0.
D. TOTAL COST (1A+1B+1C) $ 0.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 0.
****** No investment costs; Other items should be checked. ******

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 4. | 15.08 | $ 62. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 111. | $ 149. | 14.88 | $ 2213. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 111. | $ 153. | | $ 2275. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 1067.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 15877.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 15877.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 1220.

5. SIMPLE PAYBACK PERIOD (1G/4) .00 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 18152.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= ******
(IF < 1 PROJECT DOES NOT QUALIFY)

WITH ECO'S 9A & 12A

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-9
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-9 REDUCE HTW LOSSES DURING SEP START-UP
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION B
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 28652. | | |
| B. SIOH | $ 1720. | | |
| C. DESIGN COST | $ 1720. | | |
| D. TOTAL COST (1A+1B+1C) | $ 32092. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 32092. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 0. | 15.08 | $ 0. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 111. | $ 149. | 14.88 | $ 2213. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 111. | $ 149. | | $ 2213. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 9032.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 134396.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 134396.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 9181.

5. SIMPLE PAYBACK PERIOD (1G/4) 3.50 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 136609.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 4.26
(IF < 1 PROJECT DOES NOT QUALIFY)
**** Project does not qualify for ECIP funding; 4,5,6 for information only.

WITH ECO'S 9A, 12A & 12B

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-09X
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-9 REDUCE HTW LOSSES DURING SEP START-UP
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 05-06-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT
A. CONSTRUCTION COST $ 0.
B. SIOH $ 0.
C. DESIGN COST $ 0.
D. TOTAL COST (1A+1B+1C) $ 0.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 0.
****** No investment costs; Other items should be checked. ******

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 4. | 15.08 | $ 62. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 96. | $ 129. | 14.88 | $ 1914. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 96. | $ 133. | | $ 1976. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 1067.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 15877.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 15877.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 1200.

5. SIMPLE PAYBACK PERIOD (1G/4) .00 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 17853.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= ******
(IF < 1 PROJECT DOES NOT QUALIFY)

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-09Y
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-9 REDUCE HTW LOSSES DURING SEP START-UP
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 05-06-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 0. | | |
| B. SIOH | $ 0. | | |
| C. DESIGN COST | $ 0. | | |
| D. TOTAL COST (1A+1B+1C) | $ 0. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 0. |

****** No investment costs; Other items should be checked. ******

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 4. | 15.08 | $ 62. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 85. | $ 114. | 14.88 | $ 1695. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 85. | $ 118. | | $ 1757. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 1067.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 15877.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 15877.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 1185.

5. SIMPLE PAYBACK PERIOD (1G/4) .00 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 17634.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= ******
(IF < 1 PROJECT DOES NOT QUALIFY)

**RS&H**

SUBJECT: FORT STEWART
IMPROVE SEP START-UP
DESIGNER: W. TODD
CHECKER:

AEP NO: 694 1331 002
SHEET ___ OF ___
DATE: 2-1-96
DATE:

ECO-9 OPTION A

The SEP was started up from 13 NOV 95 - 23 NOV 95

The HTW system make-up water for those 11 days:

Actual HTW Make-up = 138,350 Gal.

Average HTW make-up for the previous 6 months:

$$\frac{(4.6 + 5.2 + 5.7 + 5.3 + 5.0 + 4.6)\ \text{GPM}}{6} = 5.067\ \text{GPM}$$

$$\text{Average HTW Make-up} = 5.067\ \frac{\text{GAL}}{\text{min}} \times 1440\ \frac{\text{min}}{\text{day}} \times 11\ \text{days} = \underline{80256\ \text{Gal}}$$

Assuming the SEP start-up losses = Actual - Average:

$$\text{SEP Startup losses} = 138350\ \text{GAL} - 80256\ \text{GAL} = \underline{58094\ \frac{\text{GAL}}{\text{YR}}}$$

__O&M Cost__ (Assume start-up takes 4 hr/day & 10 days)

$$\text{Current startup Costs} = 10\ \text{days} \times 8\ \frac{\text{hr}}{\text{day}} \times \$25.86/\text{hr} = \$2069/\text{YR}$$

$$\text{Proposed startup costs} = 10\ \text{days} \times 4\ \frac{\text{hr}}{\text{day}} \times \$25.86/\text{hr} = \$1034/\text{YR}$$

$$\text{O\&M Savings} = \$2069 - \$1035 = \boxed{\$1035/\text{YR}}$$

$$\text{Proposed Operating Cost} = \$13163 - \$1035 = \underline{\$12128/\text{YR}}$$

| | | | |
|---|---|---|---|
| **RS&H** | SUBJECT FORT STEWART | AEP NO 694 1331 002 | |
| | | SHEET | OF |
| | DESIGNER W. Todd | DATE 2-1-96 | |
| | CHECKER | DATE | |

ECO-9

# Satellite Energy Plant, Operating Costs - Labor

Assumptions:

1) SEP operates for $4\frac{1}{2}$ months / year
2) SEP startup takes 10 days / year
3) SEP shut down takes 3 days / yr
4) Normal operation requires one visit per shift that takes about 1 hour / visit.
5) Start-up and shut-down requires one operator Full time for one shift each day.

Pipefitters hourly rate w/ benefits = \$46.35  mm p 475

Adjusted for Savannah GA = \$46.35 × 0.558 = \$25.86  mm p 533

Labor Costs:

Startup : $10 \frac{days}{yr} \times 8 \frac{hrs}{day} \times \$25.86/hr = \$2069/YR$

Operation : $4.5 \frac{mo}{YR} \times 30 \frac{day}{mo} \times 3 \frac{hr}{day} \times \$25.86/hr = \$10473/YR$

Shut down : $3 \frac{day}{YR} \times 8 \frac{hr}{day} \times \$25.86/hr = \$621/YR$

Total Labor Cost = \$1034/YR + \$9310/YR + \$621/YR = \$13163 /YR

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. | |
| AEP Number: | 694-1331-002 | Designer: | W. T. Todd |
| Project: | Improve SEP Start-up Procedure | Date: | 02/12/96 |
| ECO Number: | 9 | | |

Assumptions:

| | | |
|---|---|---|
| 1. HTW temperature | 380 | °F |
| 2. Make-up water temperature | 70 | °F |
| 3. Boiler efficiency | 68% | |
| 4. Pump head (from record drawings) | 300 | Ft H20 |
| 5. Pump efficiency (from record drawings | 72% | |
| 6. Motor efficiency | 90% | |
| 7. Average heating fuel cost | $1.34 | /MBtu |
| 8. Electricity cost | $0.0469 | /kWh |
| 9. Water cost | $0.5562 | /kGallons |

Energy Use Calculations:

Energy Use = flow rate x specific heat x average temperature difference

58094 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 155 °F = 75.1 MBtu/Yr

Heating Fuel Use = 75.1 MBtu/yr / 0.68 = $\boxed{\text{110.5 MBtu/Yr}}$

Heating Fuel Cost = 110.5 MBtu/yr x $1.34 /MBtu = $148 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$\text{BHP} = \frac{3.67 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.39 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency ) x 0.746 kW/HP x Hr/Yr

Electric Demand = 0.39 BHP / 0.90 x 0.746 kW/HP = 0.32 kW

Electricity Use = 0.32 kW x 264 Hr/Yr = 84 kWh/Yr

Electricity Use = 84 kWh/Yr x 0.003413 MBtu/kWh = $\boxed{\text{0.3 MBtu/Yr}}$

Electricity Cost = 84 kWh/Yr x $0.0469 /kWh = $4 /Year

Water Cost:

58094 Gal/Yr x $0.5562 /kGal = $\boxed{\text{\$32 /Year}}$

Total Utility Cost:

| | | |
|---|---|---|
| Heating Fuel Cost | $148 | /Year |
| Pumping (Elec) Cost | $4 | /Year |
| Water Cost | $32 | /Year |
| Total Utility Cost | $184 | /Year |

RS&H.

SUBJECT FORT STEWART
SEP Condensate Return
DESIGNER G. Fallon
CHECKER

AEP NO 694 1331 002
SHEET ____ OF ____
DATE 2-5-96
DATE

ECO NO. 9 - OPTION B

INSTALL NEW "CONDENSATE" RETURN PUMP IN SEP.

PUMP VOLUME (1)

PUMP WILL MOVE WATER THROUGH EXISTING 4 IN CONDENSATE RETURN LINE FROM SEP TO CEP.
ASSUME 8 FT/SEC LINE VELOCITY

$$VOL.RATE = AREA \times VELOCITY = \frac{\pi D^2}{4} \times v$$
$$= 3.14/4 \times (4\,IN/12\,IN/FT)^2 \times 8\,ft/sec = 0.698\,cf/sec.$$

$$0.698\,cF/sec \times 8.34\,\#/cF \times 60\,sec/min = \boxed{349\ gpm.}$$

PUMP HEAD (1)

ACTUAL PIPE DISTANCE IS APPROXIMATELY 1 MILE WITH NO SIGNIFICANT ELEVATION CHANGE.
HEAD LOSS PER 100 FT PIPE = 6 ft/100 ft PIPE.

$$1\,mile \times 5280\,ft/mi \times \frac{6\,FT\ HEAD^*}{100\,FT\ PIPE} = \boxed{316\ FT.}$$

* ASHRAE FUNDAMENTALS HAND BOOK, CHAPTER 34, TABLE 1.

PUMP POWER (1)

$$HP = \frac{gpm \times TDH}{3960 \times \eta} = 349 \times 316 / 3960 / 0.7 = \boxed{40\ HP}$$

PUMP VOLUME (2)

ABOVE PUMP VOLUME IMPLIES A SEP STEAM CONSUMPTION OF 350 gpm X 500 PPH/gpm = 175000 #/HR WHICH IS 2 TIMES THE BOILER CAPACITY, AND IS THEREFORE TOO CONSERVATIVE.

A LESS CONSERVATIVE ESTIMATE WOULD BE BASED ON THE ASSUMPTION THAT THE EXISTING HEAT REQUIREMENT FOR THE TWO CASCADES IS APPROXIMATELY EQUAL TO 146,000 #/HR STEAM (1)

(1) SYSTEMS CORP REPORT, Pg A-1, FIG. A-1

**RS&H**

SUBJECT FORT STEWART
SEP Condensate Return
DESIGNER G. Fallon
CHECKER

AEP NO 694 1331 002
SHEET ____ OF ____
DATE 2-5-96
DATE

ECO-9B

PUMP VOLUME (2) (CONT.)

146,000 #/HR / 500 PPH/gpm = $\boxed{292 \text{ gpm}}$

PUMP POWER (2)

$$H.P. = \frac{gpm \times TDH}{3960 \times \eta} = \frac{292 \times 316}{3960 \times 0.7} = \boxed{33 \text{ H.P.}}$$

SEP SYSTEM HEAT LOSSES WITH NO HEATING LOAD.

TEST DATA SHOWED A 45F° TEMPERATURE LOSS OVER A 2 HOUR PERIOD WHEN THE AMBIENT TEMPERATURE WAS 60+°F (ASSUME NO HEAT LOAD)

ESTIMATED WATER IN SEP DISTRIBUTION PIPING IS 13,500 gal
ESTIMATED WATER IN SEP INTERNAL PIPING IS 1000 gal
CASCADE HEATER VOLUME @ NORMAL OPERATING LEVEL IS 2500 gal × 2 HEATERS = 5000 gal

TOTAL SEP CAPACITY = 13500 + 1000 + 5000 = 19500 gal

$$\text{HEAT LOSS RATE} = \frac{\text{HEAT LOSS}}{\text{TIME}} = \frac{19500\text{gal} \times 8.34 \text{ \#/gal} \times (45F°)}{2 \text{ HRS}}$$

$$= 3.66 \text{ MBTU/HR}$$

SEP BUILDING LOSSES

BLDG 2" pipe = 52 gpm
52 gpm × 500 PPH/gpm × (375 − 100) = 7.15 MBTU/HR

BLDG 1½" pipe = 28 gpm
28 gpm × 500 PPH/gpm × (375 − 100) = 3.85 MBTU/HR

BLDG. 1¼ pipe = 18 gpm
18 gpm × 500 PPH/gpm × (375 − 100) = 2.475 MBTU/HR

BLDG 1" pipe = 8.5 gpm
8.5 × 500 × (375 − 100) = 1.17 MBTU/HR

**RS&H**

SUBJECT FORT STEWART
SEP Condensate Return
DESIGNER G. Fallon
CHECKER

AEP NO 694 1331 002
SHEET ____ OF ____
DATE 2-5-96
DATE

ECO-9B

TOTAL MAX SEP LOAD

$7.15 \times 2 + 3.85 + 2.48 + 1.17 + 3.66 = \boxed{25.46 \text{ MBTU/HR}}$

MAX ACTUAL PUMP FLOW

$25.46 \text{ MBTU/HR} / (1199-360) \text{ BTU/\#s} / 500 \text{ PPH/gpm} \times 1E6 = \boxed{60.7 \text{ gpm}}$

ACTUAL PUMP POWER

$$H.P. = \frac{60.7 \text{ gpm} \times 316 \text{ ft}}{3960 \times 0.7} = \boxed{6.92 \text{ HP}} \quad \times .746 = \boxed{5.16 \text{ kw}}$$

ENERGY LOST (Assume actual losses are 50% less since water is cold at first)

138,350 Gallons - 80256 Gallons ≈ 58,100 gal (see ECO-9 calc.)

$58{,}100 \text{ gal} \times 8.34 \text{ \#/gal} \times (348.6-(68-32)) \text{ BTU/\#} / 1E6 \times .5 = 75.7 \text{ MBTU/YR}$

ENERGY LOSS VALUE (Assume 0.68 boiler eff.)

$75.7 \text{ MBTU/yr} \div 0.68 = \boxed{111.4 \text{ MBtu/YR}} \times \$1.34/\text{MBtu} = \boxed{\$149/\text{YR}}$

WATER LOSS VALUE

$58{,}100 \text{ gal} \times 0.5562 \text{ \$/1000gal} = \boxed{\$32/\text{YR}}$

PUMPING COST (ASSUME RETURN PUMPING ENERY IS THE SAME)

$58{,}100 / (11 \text{ DAYS} \times 60 \text{ m/H} \times 24 \text{ H/D}) = \boxed{3.67 \text{ gpm}}$

$$HP = \frac{3.67 \text{ gpm} \times 310 \text{ ft}}{3960 \times 0.7} = \boxed{0.41 \text{ HP}} \quad \times .746 = \boxed{0.306 \text{ kw}}$$

$0.306 \text{ KW} \times 11 \text{ DAY} \times 24 \text{ Hr/DAY} = \boxed{81 \text{ kwh/YR}} = 0.3 \frac{\text{MBtu}}{\text{YR}}$

$4847 \text{ kwh} \times 0.0469 \text{ \$/kwh} = \boxed{\$4/\text{YR}}$

| | | | |
|---|---|---|---|
| **RS&H** SUBJECT | FORT STEWART | AEP NO | 694 1331 002 |
| | | SHEET | OF |
| DESIGNER | G. FALLON | DATE | 2-9-96 |
| CHECKER | | DATE | |

ECO-9B

UTILITY COST SAVINGS

COST = ENERGY COST + WATER COST + PUMPING COST

= 149 + 32 + 4

$\boxed{= \$185}$

O & M COSTS:

SEP startup: $10 \text{ days} \times 2 \frac{\text{hours}}{\text{day}} \times \$25.86/\text{HR} = \$517/\text{YR}$

Operation: $4.5 \frac{\text{mo}}{\text{YR}} \times 30 \frac{\text{day}}{\text{mo}} \times 1 \frac{\text{hr}}{\text{day}} \times \$25.86/\text{HR} = \$3,491/\text{YR}$

Shut down: $3 \text{ days} \times 2 \frac{\text{hours}}{\text{day}} \times \$25.86/\text{HR} = \$155/\text{YR}$

Total Operating Costs = $4163/YR

ANNUAL SAVINGS

HEATING FUELS = $\boxed{111 \text{ MBtu/YR}}$ SAME AS OPTION A

ELECTRICITY = 0.3 - 0.3 = $\boxed{0 \text{ MBtu/YR}}$

WATER = $\boxed{\$32/\text{YR}}$

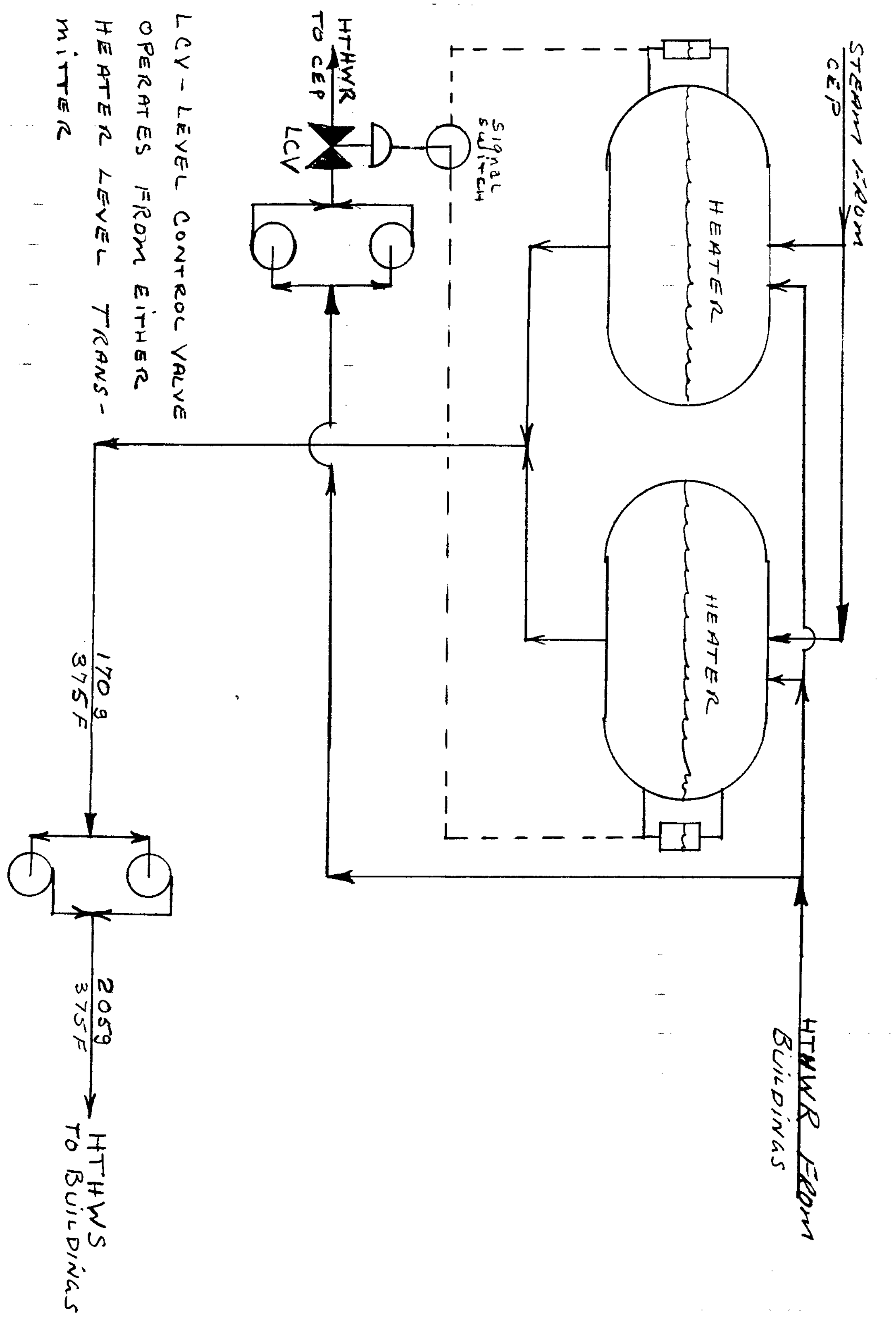
O & M = $13163 - $4163 = $\boxed{\$9000/\text{YR}}$

**RS&H**

SUBJECT: FORT STEWART
Pump for SEP to CEP
DESIGNER: G. Fallon
CHECKER:

AEP NO: 694 1331 002
SHEET: OF:
DATE: 2-9-96
DATE:

ECO-9B




912-767-8931

A.3.9-13

# CONSTRUCTION COST ESTIMATE

| | | | |
|---|---|---|---|
| Project: | Install new Return Pump in the SEP | RS&H No.: | 694-1331-002 |
| Location: | Fort Stewart, GA | Date: | 02/14/96 |
| Basis: | Schematic Design | Estimator: | G. W. Fallon |
| ECO No.: | 9B | Filename: | EST-9B.WB2 |

| ITEM DESCRIPTION | QUANTITY | | MATERIAL/EQUIP | | LABOR | | TOTAL COST | SOURCE | |
|---|---|---|---|---|---|---|---|---|---|
| | No. | Unit | $/Unit | Total | $/Unit | Total | | Material | Labor |
| Pump, 300 gpm, 310' hd | 2 | Ea | 2325 | 4650 | 480 | 960 | 5,610 | MMp202 | MMp202 |
| Iso. Valves, 4", 300 lb | 4 | Ea | 1300 | 5200 | 155 | 620 | 5,820 | MMp197 | MMp197 |
| Elbows, 4", Weld Joint | 4 | Ea | 17.50 | 70 | 97.05 | 388 | 458 | MMp158 | MMp158 |
| Flange, 4", 400 lb, W.N. | 8 | Ea | 44.00 | 352 | 60.60 | 485 | 837 | MMp165 | MMp165 |
| Pipe, 4", Sch. 80, W.E. | 40 | LF | 16.05 | 642 | 14.70 | 588 | 1,230 | MMp142 | MMp142 |
| Welding Labor/Joint | 36 | Ea | 0 | 0 | 60.60 | 2182 | 2,182 | MMp144 | MMp144 |
| Level Control Valve | 1 | Ea | 5000 | 5000 | 2000 | 2000 | 7,000 | Estimate | Estimate |
| Elec. Conn. 480V, 30 hp | 2 | Ea | 1125 | 2250 | 1000 | 2000 | 4,250 | MEp320 | MEp320 |
| Subtotal Bare Costs | | | | 18164 | | 9223 | $27,387 | | |
| Retrofit Cost Factors | | | 0% | 0 | 0% | 0 | 0 | MMp6 | MMp6 |
| Subtotal | | | | 18164 | | 9223 | 27,387 | | |
| City Cost Index (Sav. GA) | | | 0% | 0 | -44% | -4077 | (4,077) | MMp533 | MMp533 |
| Subtotal | | | | 18164 | | 5146 | 23,310 | | |
| OH & Profit Markups | | | 10% | 1816 | 53% | 2727 | 4,543 | MMp7 | MMp475 |
| Subtotal | | | | 19980 | | 7873 | 27,853 | | |
| Sales Taxes | | | 4.0% | 799 | | NA | 799 | MMp476 | |
| Total Construction Cost | | | | 20779 | | 7873 | 28,652 | | |
| Design Fee | | | | NA | 6.0% | 1719 | 1,719 | | |
| SIOH | | | | NA | 6.0% | 1719 | 1,719 | | |
| Subtotal | | | | 20779 | | 11311 | 32,090 | | |
| Contingency | | | 0% | 0 | 0% | 0 | 0 | MEp6 | MEp6 |
| Total Project Cost | | | | 20779 | | 11311 | $32,090 | | |

LEGEND:

MEp### 1996 Means Electrical Cost Data, page ###.

MMp### 1996 Means Mechanical Cost Data, page ###.

ECO-9A

1995 DAILY MAKEUP WATER

| MONTH | DAY | GAL/DAY | TOTAL | AVG GPD | GAL/MIN | AVG GPM |
|---|---|---|---|---|---|---|
| | 1 | 4020 | | | 2.8 | |
| | 2 | 5090 | | | 3.5 | |
| | 3 | 3730 | | | 2.6 | |
| | 4 | 7330 | | | 5.1 | |
| | 5 | 2280 | | | 1.6 | |
| | 6 | 7650 | | | 5.3 | |
| | 7 | 2440 | | | 1.7 | |
| | 8 | 3700 | | | 2.6 | |
| | 9 | 9110 | | | 6.3 | |
| | 10 | 10140 | | | 7.0 | |
| | 11 | 5410 | | | 3.8 | |
| | 12 | 6830 | | | 4.7 | |
| | 13 | 10080 | | | 7.0 | |
| | 14 | 9320 | | | 6.5 | |
| NOV | 15 | 12200 | | 8708 | 8.5 | 6.0 |
| | 16 | 13450 | | | 9.3 | |
| | 17 | 16220 | | | 11.3 | |
| | 18 | 14560 | Total = 138,350 | | 10.1 | |
| | 19 | 10130 | | | 7.0 | |
| | 20 | 13380 | | | 9.3 | |
| | 21 | 14530 | | | 10.1 | |
| | 22 | 14460 | | | 10.0 | |
| | 23 | 10020 | | | 7.0 | |
| | 24 | 7950 | | | 5.5 | |
| | 25 | 11720 | | | 8.1 | |
| | 26 | 4100 | | | 2.8 | |
| | 27 | 4450 | | | 3.1 | |
| | 28 | 10070 | | | 7.0 | |
| | 29 | 9450 | | | 6.6 | |
| | 30 | 7410 | 261230 | | 5.1 | |
| | 1 | 7430 | | | 5.2 | |
| | 2 | 9300 | | | 6.5 | |
| | 3 | 10090 | | | 7.0 | |
| | 4 | 8930 | | | 6.2 | |
| | 5 | 9170 | | | 6.4 | |
| | 6 | 6500 | | | 4.5 | |
| | 7 | 9930 | | | 6.9 | |
| | 8 | 7770 | | | 5.4 | |
| | 9 | 7430 | | | 5.2 | |
| | 10 | 9410 | | | 6.5 | |
| | 11 | 9100 | | | 6.3 | |
| | 12 | 8010 | | | 5.6 | |
| | 13 | 9780 | | | 6.8 | |
| | 14 | 9470 | | | 6.6 | |
| DEC | 15 | 10930 | | 8371 | 7.6 | 5.8 |
| | 16 | 8650 | | | 6.0 | |
| | 17 | 9770 | | | 6.8 | |
| | 18 | 8500 | | | 5.9 | |
| | 19 | 6790 | | | 4.7 | |
| | 20 | 7300 | | | 5.1 | |
| | 21 | 7620 | | | 5.3 | |
| | 22 | 4110 | | | 2.9 | |
| | 23 | 6220 | | | 4.3 | |
| | 24 | 7180 | | | 5.0 | |
| | 25 | 4420 | | | 3.1 | |
| | 26 | 5050 | | | 3.5 | |
| | 27 | 7010 | | | 4.9 | |
| | 28 | 9310 | | | 6.5 | |
| | 29 | 10690 | | | 7.4 | |
| | 30 | 11030 | | | 7.7 | |
| | 31 | 12610 | 259510 | | 8.8 | |

ECO-9A

# OPERATING INSTRUCTIONS

## CASCADE WATER HEATER

### I. DESCRIPTION

The Chicago Heater Company cascade hot water heater has been specifically designed to handle all of the system returns outlined in the contract specifications. In order to insure the most efficient use of steam pressure and energy level in the cycle and the lowest operating cost, these specified design rates of flow should not be exceeded.

The cascade heater is a direct contact heat exchanger, heating in such a machine is achieved by passing carefully controlled streams of water through a steam atmosphere.

### II. OPERATION

System returns enter the cascade heater through the water inlet nozzle provided on the shell. These returns are conveyed upward through ducting within the unit to a distributor weir over which they cascade downward on to specially designed water distributing trays. These trays break up the water into thin streams to expose the greatest surface area to the steam which fills the heating section. In the steam space the water is heated to within 10° of the steam temperature. The hot water leaving the heating element falls into the storage compartment and is ready for service.

### III. BEFORE START UP

This equipment should not be started until all operating personnel are familiar with the start up procedures herein outlined. Particular attention should be paid to the operation of the various controls furnished with the cascade heater.

Prior to admitting water and steam to the unit, the following equipment should be checked.

A. The atmospheric vent should be wide open. Note: At low starting loads it may be necessary to throttle this valve slightly to bring the unit up to pressure, but in no case is the valve to be fully closed.

B. The relief valve should be checked to be certain that gags and shipping stops have been removed.

C. Manually operate all controls. Control valves should be checked for correct travel, freedom from friction, and correct action to match their controlling instrument. For successful operation, the actuator stem and valve plug stem must move freely in response to loading pressure changes on the diaphragm.

D. Alarm switches should be checked to be certain that the switches are installed for proper function and alarm devices are operational.

E. Thermometer, pressure gauges, and all recording instruments should be properly calibrated.

## IV. START UP

The following procedures should be followed when commencing operation of the cascade heater after all equipment has been tested and checked.

1. Flush out all lines and tanks with water until there is no apparent indication of foreign matter or rust.

2. Close outlet valve from heater to feed pumps.

3. Start flow of inlet water and slowly increase from 50 to 60 per cent of design rate.

4. Open valve admitting steam into tank slowly. Possibly some rumbling may occur but this may be disregarded with the cold tank. Check steam gauge in the heater and make absolutely certain that positive steam pressure is maintained in the heater; if steam supply is insufficient, utilize other sources such as live steam through a reducing valve or any other auxiliary steam supply.

5. Filling the vessel with water will purge most of the air from the tank. As the water approaches operating level, increase the steam flow. Caution: Filling the tank with steam and then flooding with cold water subjects the tank to undue stresses caused by vacuum created by rapid condensation. Never fill the vessel with steam and admit cold water.

6. As the water reaches the operating level, check the operation of inlet controllers. Make adjustments at all controllers. Manually continue the flow of water until high level controls operate. Check operating level of controllers and alarms at this point.

7. When a considerable volume of steam is issuing from the vent valve, commence throttling back vent valve until only a plume of vapor can be seen issuing from it. At this point the water temperature within the unit whould be within 10° of saturation temperature of steam at heater pressure. A lower water temperature indicates that pockets of air have left and completely purged. If this occurs, open steam valve wide, then open vent valve wide for a few seconds, then throttle back to force pockets to the vent.

8. Open steam valve wide.

9. The unit is now ready for service and the outlet valve may be opened and admit water to the feed pumps. When the unit is operating correctly, the storage water temperature should be within 10° of the saturated temperature of the steam at heater pressure.

10. For any special equipment that has been supplied with this unit, check the descriptive literature and operating instructions for that equipment.

## R010-070 Contractor's Overhead & Profit

Below are the average installing contractor's percentage mark-ups applied to base labor rates to arrive at typical billing rates.

**Column A:** Labor rates are based on union wages averaged for 30 major U.S. cities. Base rates including fringe benefits are listed hourly and daily. These figures are the sum of the wage rate and employer-paid fringe benefits such as vacation pay, employer-paid health and welfare costs, pension costs, plus appropriate training and industry advancement funds costs.

**Column B:** Workers' Compensation rates are the national average of state rates established for each trade.

**Column C:** Column C lists average fixed overhead figures for all trades. Included are Federal and State Unemployment costs set at 7.3%; Social Security Taxes (FICA) set at 7.65%; Builder's Risk Insurance costs set at 0.34%; and Public Liability costs set at 1.55%. All the percentages except those for Social Security Taxes vary from state to state as well as from company to company.

**Columns D and E:** Percentages in Columns D and E are based on the presumption that the installing contractor has annual billing of $500,000 and up. Overhead percentages may increase with sma annual billing. The overhead percentages for any given contract vary greatly and depend on a number of factors, such as the co annual volume, engineering and logistical support costs, and s requirements. The figures for overhead and profit will also vary depending on the type of job, the job location, and the prevaili economic conditions. All factors should be examined very careft each job.

**Column F:** Column F lists the total of Columns B, C, D, and E.

**Column G:** Column G is Column A (hourly base labor rate) multiplied by the percentage in Column F (O&P percentage).

**Column H:** Column H is the total of Column A (hourly base labor rate) plus Column G (Total O&P).

**Column I:** Column I is Column H multiplied by eight hours.

| | | A | | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Base Rate Incl. Fringes | | Workers' Comp. | Average Fixed Overhead | Overhead | | Total Overhead & Profit | | Rate with O & P | |
| Abbr. | Trade | Hourly | Daily | Ins. | | | Profit | % | Amount | Hourly | Daily |
| Skwk | Skilled Workers Average (35 trades) | $25.95 | $207.60 | 20.2% | 16.8% | 13.0% | 10.0% | 60.0% | $15.55 | $41.50 | $332.00 |
| | Helpers Average (5 trades) | 19.25 | 154.00 | 21.4 | | 11.0 | | 59.2 | 11.40 | 30.65 | 245.20 |
| | Foreman Average, Inside ($.50 over trade) | 26.45 | 211.60 | 20.2 | | 13.0 | | 60.0 | 15.85 | 42.30 | 338.40 |
| | Foreman Average, Outside ($2.00 over trade) | 27.95 | 223.60 | 20.2 | | 13.0 | | 60.0 | 16.75 | 44.70 | 357.60 |
| Clab | Common Building Laborers | 19.80 | 158.40 | 21.9 | | 11.0 | | 59.7 | 11.80 | 31.60 | 252.80 |
| Asbe | Asbestos Workers | 28.55 | 228.40 | 19.7 | | 16.0 | | 62.5 | 17.85 | 46.40 | 371.20 |
| Boil | Boilermakers | 30.05 | 240.40 | 17.7 | | 16.0 | | 60.5 | 18.20 | 48.25 | 386.00 |
| Bric | Bricklayers | 25.90 | 207.20 | 19.4 | | 11.0 | | 57.2 | 14.80 | 40.70 | 325.60 |
| Brhe | Bricklayer Helpers | 20.00 | 160.00 | 19.4 | | 11.0 | | 57.2 | 11.45 | 31.45 | 251.60 |
| Carp | Carpenters | 25.20 | 201.60 | 21.9 | | 11.0 | | 59.7 | 15.05 | 40.25 | 322.00 |
| Cefi | Cement Finishers | 24.35 | 194.80 | 12.8 | | 11.0 | | 50.6 | 12.30 | 36.65 | 293.20 |
| Elec | Electricians | 29.30 | 234.40 | 8.0 | | 16.0 | | 50.8 | 14.90 | 44.20 | 353.60 |
| Elev | Elevator Constructors | 30.05 | 240.40 | 9.6 | | 16.0 | | 52.4 | 15.75 | 45.80 | 366.40 |
| Eqhv | Equipment Operators, Crane or Shovel | 26.75 | 214.00 | 12.9 | | 14.0 | | 53.7 | 14.35 | 41.10 | 328.80 |
| Eqmd | Equipment Operators, Medium Equipment | 25.70 | 205.60 | 12.9 | | 14.0 | | 53.7 | 13.80 | 39.50 | 316.00 |
| Eqlt | Equipment Operators, Light Equipment | 24.70 | 197.60 | 12.9 | | 14.0 | | 53.7 | 13.25 | 37.95 | 303.60 |
| Eqol | Equipment Operators, Oilers | 21.90 | 175.20 | 12.9 | | 14.0 | | 53.7 | 11.75 | 33.65 | 269.20 |
| Eqmm | Equipment Operators, Master Mechanics | 27.55 | 220.40 | 12.9 | | 14.0 | | 53.7 | 14.80 | 42.35 | 338.80 |
| Glaz | Glaziers | 24.90 | 199.20 | 16.0 | | 11.0 | | 53.8 | 13.40 | 38.30 | 306.40 |
| Lath | Lathers | 24.95 | 199.60 | 13.5 | | 11.0 | | 51.3 | 12.80 | 37.75 | 302.00 |
| Marb | Marble Setters | 25.65 | 205.20 | 19.4 | | 11.0 | | 57.2 | 14.65 | 40.30 | 322.40 |
| Mill | Millwrights | 26.55 | 212.40 | 13.2 | | 11.0 | | 51.0 | 13.55 | 40.10 | 320.80 |
| Mstz | Mosaic and Terrazzo Workers | 25.25 | 202.00 | 11.0 | | 11.0 | | 48.8 | 12.30 | 37.55 | 300.40 |
| Pord | Painters, Ordinary | 22.95 | 183.60 | 16.8 | | 11.0 | | 54.6 | 12.55 | 35.50 | 284.00 |
| Psst | Painters, Structural Steel | 23.95 | 191.60 | 62.5 | | 11.0 | | 100.3 | 24.00 | 47.95 | 383.60 |
| Pape | Paper Hangers | 23.30 | 186.40 | 16.8 | | 11.0 | | 54.6 | 12.70 | 36.00 | 288.00 |
| Pile | Pile Drivers | 25.35 | 202.80 | 33.6 | | 16.0 | | 76.4 | 19.35 | 44.70 | 357.60 |
| Plas | Plasterers | 24.20 | 193.60 | 17.4 | | 11.0 | | 55.2 | 13.35 | 37.55 | 300.40 |
| Plah | Plasterer Helpers | 20.15 | 161.20 | 17.4 | | 11.0 | | 55.2 | 11.10 | 31.25 | 250.00 |
| Plum | Plumbers | 30.05 | 240.40 | 10.2 | | 16.0 | | 53.0 | 15.95 | 46.00 | 368.00 |
| Rodm | Rodmen (Reinforcing) | 27.75 | 222.00 | 36.3 | | 14.0 | | 77.1 | 21.40 | 49.15 | 393.20 |
| Rofc | Roofers, Composition | 22.55 | 180.40 | 37.4 | | 11.0 | | 75.2 | 16.95 | 39.50 | 316.00 |
| Rots | Roofers, Tile and Slate | 22.60 | 180.80 | 37.4 | | 11.0 | | 75.2 | 17.00 | 39.60 | 316.80 |
| Rohe | Roofer Helpers (Composition) | 15.95 | 127.60 | 37.4 | | 11.0 | | 75.2 | 12.00 | 27.95 | 223.60 |
| Shee | Sheet Metal Workers | 28.95 | 231.60 | 13.8 | | 16.0 | | 56.6 | 16.40 | 45.35 | 362.80 |
| Spri | Sprinkler Installers | 31.30 | 250.40 | 10.4 | | 16.0 | | 53.2 | 16.65 | 47.95 | 383.60 |
| Stpi | Steamfitters or Pipefitters | 30.30 | 242.40 | 10.2 | | 16.0 | | 53.0 | 16.05 | 46.35 | 370.80 |
| Ston | Stone Masons | 25.90 | 207.20 | 19.4 | | 11.0 | | 57.2 | 14.80 | 40.70 | 325.60 |
| Sswk | Structural Steel Workers | 27.85 | 222.80 | 46.4 | | 14.0 | | 87.2 | 24.30 | 52.15 | 417.20 |
| Tilf | Tile Layers | 25.05 | 200.40 | 11.0 | | 11.0 | | 48.8 | 12.20 | 37.25 | 298.00 |
| Tilh | Tile Layer Helpers | 20.30 | 162.40 | 11.0 | | 11.0 | | 48.8 | 9.90 | 30.20 | 241.60 |
| Trlt | Truck Drivers, Light | 20.35 | 162.80 | 17.0 | | 11.0 | | 54.8 | 11.15 | 31.50 | 252.00 |
| Trhv | Truck Drivers, Heavy | 20.70 | 165.60 | 17.0 | | 11.0 | | 54.8 | 11.35 | 32.05 | 256.40 |
| Sswl | Welders, Structural Steel | 27.85 | 222.80 | 46.4 | | 14.0 | | 87.2 | 24.30 | 52.15 | 417.20 |
| Wrck | *Wrecking | 19.80 | 158.40 | 44.8 | | 11.0 | | 82.6 | 16.35 | 36.15 | 289.20 |

*Not included in Averages.

A.3.9-19

| DIVISION | FLORIDA | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MIAMI | | | ORLANDO | | | PANAMA CITY | | | PENSACOLA | | | ST. PETERSBURG | | | TALLAHASSEE | | |
| | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL |
| 2 SITE WORK | 110.3 | 72.8 | 81.5 | 125.3 | 85.9 | 95.0 | 141.6 | 83.4 | 96.9 | 138.9 | 85.9 | 98.1 | 126.2 | 85.6 | 95.0 | 125.7 | 85.2 | 94.6 |
| 031 CONCRETE FORMWORK | 94.2 | 71.0 | 74.5 | 97.3 | 71.6 | 75.5 | 95.8 | 37.8 | 46.6 | 84.5 | 69.7 | 72.0 | 94.1 | 64.8 | 69.3 | 97.3 | 53.0 | 59.7 |
| 032 CONCRETE REINFORCEMENT | 95.1 | 72.5 | 82.4 | 95.1 | 79.0 | 86.0 | 99.3 | 64.5 | 79.7 | 101.5 | 64.9 | 81.0 | 98.5 | 74.3 | 84.9 | 95.1 | 65.2 | 78.3 |
| 033 CAST IN PLACE CONCRETE | 91.5 | 75.4 | 84.6 | 88.7 | 78.0 | 84.1 | 95.2 | 43.0 | 72.9 | 95.2 | 69.0 | 84.0 | 101.4 | 70.2 | 88.1 | 91.7 | 58.4 | 77.5 |
| 3 CONCRETE | 87.4 | 74.3 | 80.8 | 86.3 | 76.7 | 81.4 | 95.0 | 46.6 | 70.5 | 93.5 | 70.1 | 81.7 | 92.6 | 70.1 | 81.2 | 87.7 | 59.2 | 73.3 |
| 4 MASONRY | 76.9 | 70.2 | 72.8 | 77.4 | 75.6 | 76.2 | 84.9 | 37.4 | 55.4 | 82.6 | 67.6 | 73.3 | 119.2 | 66.9 | 86.7 | 83.6 | 52.6 | 64.4 |
| 5 METALS | 98.8 | 93.5 | 96.8 | 107.9 | 95.0 | 103.0 | 97.2 | 75.1 | 88.9 | 97.1 | 89.6 | 94.3 | 101.0 | 92.4 | 97.7 | 99.2 | 88.1 | 95.0 |
| 6 WOOD & PLASTICS | 88.6 | 72.7 | 80.6 | 94.5 | 71.1 | 82.8 | 92.9 | 38.3 | 65.6 | 80.1 | 71.1 | 75.6 | 90.8 | 65.2 | 78.0 | 94.5 | 51.6 | 73.0 |
| 7 THERMAL & MOISTURE PROTECTION | 99.6 | 74.6 | 88.0 | 96.6 | 75.6 | 86.9 | 96.9 | 38.3 | 69.9 | 96.6 | 66.9 | 82.9 | 96.3 | 63.1 | 81.0 | 96.6 | 58.8 | 79.1 |
| 8 DOORS & WINDOWS | 95.9 | 69.5 | 89.5 | 98.1 | 68.2 | 90.9 | 95.7 | 35.2 | 81.2 | 95.7 | 66.5 | 88.7 | 96.8 | 60.4 | 88.0 | 98.1 | 53.9 | 87.4 |
| 092 LATH, PLASTER & GYPSUM BOARD | 101.0 | 72.5 | 82.5 | 101.6 | 70.8 | 81.7 | 99.7 | 36.9 | 59.0 | 94.5 | 70.9 | 79.2 | 98.9 | 64.8 | 76.8 | 101.6 | 50.7 | 68.6 |
| 095 ACOUSTICAL TREATMENT & WOOD FLOORING | 102.4 | 72.5 | 83.0 | 102.4 | 70.8 | 82.0 | 96.6 | 36.9 | 58.0 | 96.6 | 70.9 | 79.9 | 98.0 | 64.8 | 76.5 | 102.4 | 50.7 | 68.9 |
| 096 FLOORING & CARPET | 121.8 | 75.3 | 110.7 | 113.0 | 74.9 | 103.8 | 112.3 | 24.6 | 91.3 | 106.7 | 68.0 | 97.4 | 111.4 | 67.8 | 100.9 | 113.0 | 49.7 | 97.8 |
| 099 PAINTING & WALL COVERINGS | 100.9 | 70.1 | 83.0 | 104.2 | 77.6 | 88.7 | 104.2 | 34.5 | 63.7 | 104.2 | 78.5 | 89.3 | 104.2 | 65.4 | 81.6 | 104.2 | 55.7 | 76.0 |
| 9 FINISHES | 108.6 | 71.4 | 89.7 | 107.7 | 72.7 | 89.9 | 107.2 | 34.4 | 70.2 | 104.5 | 70.5 | 87.2 | 106.0 | 65.3 | 85.3 | 107.7 | 51.9 | 79.3 |
| 10-14 TOTAL DIV. 10-14 | 100.0 | 81.8 | 96.1 | 100.0 | 83.9 | 96.6 | 100.0 | 65.4 | 92.6 | 100.0 | 73.3 | 94.3 | 100.0 | 76.8 | 95.1 | 100.0 | 74.0 | 94.5 |
| 15 MECHANICAL | 100.0 | 72.9 | 88.0 | 100.0 | 70.8 | 87.1 | 100.0 | 34.6 | 71.1 | 100.0 | 68.8 | 86.2 | 100.0 | 68.7 | 86.2 | 100.0 | 54.8 | 80.0 |
| 16 ELECTRICAL | 98.0 | 84.9 | 89.3 | 98.0 | 63.0 | 74.6 | 96.3 | 47.1 | 63.5 | 101.8 | 63.4 | 76.2 | 98.5 | 68.1 | 78.2 | 98.0 | 58.3 | 71.5 |
| 1-16 WEIGHTED AVERAGE | 97.5 | 76.7 | 87.4 | 99.2 | 75.1 | 87.6 | 99.2 | 48.1 | 74.5 | 98.8 | 71.8 | 85.7 | 101.0 | 71.8 | 86.9 | 98.5 | 62.1 | 80.9 |

| DIVISION | FLORIDA | | | GEORGIA | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TAMPA | | | ALBANY | | | ATLANTA | | | AUGUSTA | | | COLUMBUS | | | MACON | | |
| | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL |
| 2 SITE WORK | 126.9 | 85.6 | 95.1 | 110.4 | 74.2 | 82.5 | 114.3 | 92.8 | 97.8 | 110.2 | 91.5 | 95.8 | 110.4 | 74.3 | 82.6 | 111.6 | 91.9 | 96.5 |
| 031 CONCRETE FORMWORK | 97.3 | 64.9 | 69.8 | 96.9 | 50.8 | 57.8 | 98.0 | 70.3 | 74.5 | 94.5 | 61.8 | 66.7 | 96.9 | 50.4 | 57.4 | 95.9 | 65.9 | 70.5 |
| 032 CONCRETE REINFORCEMENT | 95.1 | 74.3 | 83.4 | 95.1 | 76.4 | 84.6 | 98.5 | 77.5 | 86.7 | 104.0 | 69.1 | 84.4 | 95.1 | 76.4 | 84.6 | 97.4 | 76.7 | 85.8 |
| 033 CAST IN PLACE CONCRETE | 101.7 | 70.2 | 88.2 | 95.5 | 48.9 | 75.6 | 101.1 | 71.2 | 88.3 | 95.6 | 57.9 | 79.5 | 95.5 | 49.5 | 75.8 | 95.5 | 53.3 | 77.5 |
| 3 CONCRETE | 92.4 | 70.2 | 81.2 | 89.4 | 57.0 | 73.0 | 94.0 | 72.1 | 82.9 | 90.5 | 62.2 | 76.2 | 89.4 | 57.0 | 73.0 | 89.7 | 65.1 | 77.3 |
| 4 MASONRY | 82.8 | 66.9 | 72.9 | 83.4 | 38.9 | 55.7 | 92.1 | 63.6 | 74.4 | 92.2 | 49.1 | 65.4 | 83.4 | 39.3 | 56.0 | 98.6 | 46.7 | 66.4 |
| 5 METALS | 102.2 | 92.4 | 98.5 | 96.8 | 89.0 | 93.9 | 93.7 | 74.5 | 86.4 | 92.4 | 69.4 | 83.7 | 96.7 | 89.3 | 93.9 | 91.7 | 90.1 | 91.1 |
| 6 WOOD & PLASTICS | 94.5 | 65.2 | 79.8 | 93.7 | 51.6 | 72.6 | 99.7 | 72.2 | 86.0 | 95.9 | 64.6 | 80.3 | 93.7 | 51.3 | 72.5 | 97.4 | 69.9 | 83.6 |
| 7 THERMAL & MOISTURE PROTECTION | 96.6 | 64.3 | 81.7 | 96.4 | 55.7 | 77.6 | 94.2 | 70.0 | 83.0 | 93.6 | 59.5 | 77.9 | 96.1 | 55.7 | 77.5 | 95.1 | 62.9 | 80.2 |
| 8 DOORS & WINDOWS | 98.1 | 60.4 | 89.0 | 95.9 | 53.7 | 85.7 | 94.2 | 67.9 | 87.9 | 90.6 | 59.3 | 83.1 | 95.9 | 53.8 | 85.7 | 94.2 | 64.8 | 87.1 |
| 092 LATH, PLASTER & GYPSUM BOARD | 101.6 | 64.8 | 77.7 | 101.6 | 50.7 | 68.6 | 112.5 | 72.0 | 86.2 | 111.3 | 64.1 | 80.7 | 101.6 | 50.4 | 68.4 | 108.3 | 69.5 | 83.2 |
| 095 ACOUSTICAL TREATMENT & WOOD FLOORING | 102.4 | 64.8 | 78.1 | 102.4 | 50.7 | 69.0 | 108.7 | 72.0 | 84.9 | 108.7 | 64.1 | 79.8 | 102.4 | 50.4 | 68.7 | 95.9 | 69.5 | 78.8 |
| 096 FLOORING & CARPET | 113.0 | 67.8 | 102.1 | 113.0 | 40.4 | 95.6 | 87.8 | 75.0 | 84.8 | 86.7 | 51.5 | 78.2 | 113.0 | 41.0 | 95.7 | 87.8 | 47.5 | 78.2 |
| 099 PAINTING & WALL COVERINGS | 104.2 | 65.4 | 81.6 | 100.9 | 50.4 | 71.5 | 99.0 | 72.1 | 83.4 | 99.0 | 47.9 | 69.3 | 100.9 | 48.3 | 70.3 | 102.4 | 59.0 | 77.2 |
| 9 FINISHES | 107.7 | 65.3 | 86.1 | 105.8 | 48.1 | 76.4 | 95.1 | 71.5 | 83.1 | 94.4 | 58.6 | 76.1 | 105.7 | 47.8 | 76.2 | 91.5 | 62.0 | 76.5 |
| 10-14 TOTAL DIV. 10-14 | 100.0 | 76.8 | 95.1 | 100.0 | 69.5 | 93.5 | 100.0 | 75.4 | 94.8 | 100.0 | 71.0 | 93.8 | 100.0 | 69.4 | 93.5 | 100.0 | 73.6 | 94.4 |
| 15 MECHANICAL | 100.0 | 68.7 | 86.2 | 100.0 | 56.8 | 80.9 | 100.1 | 71.7 | 87.5 | 100.1 | 54.0 | 79.7 | 100.0 | 46.2 | 76.2 | 100.0 | 52.1 | 78.8 |
| 16 ELECTRICAL | 97.5 | 68.1 | 77.9 | 93.3 | 68.1 | 76.5 | 93.4 | 82.3 | 86.0 | 96.9 | 61.3 | 73.2 | 93.3 | 49.4 | 64.0 | 91.4 | 63.3 | 72.7 |
| 1-16 WEIGHTED AVERAGE | 99.5 | 71.8 | 86.1 | 97.1 | 60.8 | 79.5 | 96.5 | 75.0 | 86.1 | 95.5 | 62.5 | 79.5 | 97.1 | 55.7 | 77.1 | 95.4 | 65.4 | 80.9 |

| DIVISION | GEORGIA | | | | | | HAWAII | | | IDAHO | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SAVANNAH | | | VALDOSTA | | | HONOLULU | | | BOISE | | | LEWISTON | | | POCATELLO | | |
| | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL |
| 2 SITE WORK | 110.6 | 76.1 | 84.0 | 122.0 | 74.5 | 85.5 | 115.0 | 112.0 | 112.7 | 86.4 | 99.3 | 96.3 | 90.4 | 92.7 | 92.2 | 89.1 | 99.3 | 96.9 |
| 031 CONCRETE FORMWORK | 97.0 | 60.5 | 66.0 | 80.8 | 51.9 | 56.3 | 102.1 | 158.7 | 150.1 | 97.4 | 89.3 | 90.5 | 106.3 | 87.1 | 90.0 | 97.4 | 89.3 | 90.5 |
| 032 CONCRETE REINFORCEMENT | 100.7 | 69.5 | 83.2 | 100.8 | 50.3 | 72.5 | 109.9 | 125.0 | 118.4 | 96.0 | 78.4 | 86.1 | 108.6 | 96.1 | 101.6 | 96.3 | 78.5 | 86.3 |
| 033 CAST IN PLACE CONCRETE | 91.5 | 56.6 | 76.6 | 93.0 | 57.4 | 77.8 | 170.2 | 127.7 | 152.0 | 98.6 | 93.8 | 96.6 | 107.8 | 93.9 | 101.8 | 99.6 | 93.8 | 97.1 |
| 3 CONCRETE | 88.3 | 62.5 | 75.3 | 92.8 | 55.5 | 74.0 | 153.0 | 139.4 | 146.1 | 103.2 | 88.7 | 95.9 | 115.5 | 91.0 | 103.1 | 103.7 | 88.6 | 96.1 |
| 4 MASONRY | 86.9 | 57.6 | 68.7 | 89.8 | 50.6 | 65.4 | 131.3 | 134.3 | 133.2 | 131.8 | 81.0 | 100.2 | 128.8 | 96.6 | 108.8 | 136.3 | 82.7 | 103.0 |
| 5 METALS | 97.1 | 87.6 | 93.5 | 96.5 | 80.7 | 90.6 | 117.4 | 107.6 | 113.7 | 112.9 | 82.2 | 101.3 | 96.2 | 90.7 | 94.1 | 112.5 | 82.2 | 101.1 |
| 6 WOOD & PLASTICS | 93.8 | 60.9 | 77.3 | 76.0 | 50.3 | 63.1 | 100.6 | 165.6 | 133.1 | 95.1 | 88.5 | 91.8 | 98.7 | 83.6 | 91.2 | 95.1 | 88.5 | 91.8 |
| 7 THERMAL & MOISTURE PROTECTION | 96.4 | 59.2 | 79.3 | 96.1 | 60.0 | 79.5 | 109.5 | 133.7 | 120.6 | 97.9 | 84.0 | 91.5 | 167.6 | 89.8 | 131.7 | 98.0 | 83.8 | 91.5 |
| 8 DOORS & WINDOWS | 95.9 | 56.7 | 86.4 | 91.4 | 46.3 | 80.5 | 110.6 | 146.5 | 119.2 | 94.9 | 81.7 | 91.7 | 116.3 | 85.0 | 108.7 | 94.9 | 78.5 | 91.0 |
| 092 LATH, PLASTER & GYPSUM BOARD | 101.6 | 60.4 | 74.9 | 93.7 | 49.4 | 65.0 | 95.7 | 167.7 | 142.3 | 89.0 | 87.9 | 88.3 | 135.3 | 83.0 | 101.4 | 89.0 | 87.9 | 88.3 |
| 095 ACOUSTICAL TREATMENT & WOOD FLOORING | 102.4 | 60.4 | 75.2 | 98.0 | 49.4 | 66.5 | 132.8 | 167.7 | 155.4 | 96.2 | 87.9 | 90.8 | 144.9 | 83.0 | 104.8 | 96.2 | 87.9 | 90.8 |
| 096 FLOORING & CARPET | 113.0 | 60.7 | 100.4 | 105.1 | 48.5 | 91.5 | 127.8 | 128.3 | 127.9 | 97.5 | 74.8 | 92.1 | 135.1 | 97.9 | 126.2 | 97.5 | 74.8 | 92.1 |
| 099 PAINTING & WALL COVERINGS | 100.9 | 59.9 | 77.0 | 100.9 | 43.7 | 67.6 | 123.8 | 148.0 | 137.9 | 109.4 | 67.9 | 85.2 | 134.4 | 91.3 | 109.3 | 109.4 | 78.2 | 91.3 |
| 9 FINISHES | 105.8 | 60.5 | 82.8 | 101.9 | 50.0 | 75.5 | 124.5 | 153.9 | 139.5 | 93.2 | 84.6 | 88.8 | 156.4 | 89.0 | 122.1 | 93.2 | 85.8 | 89.4 |
| 10-14 TOTAL DIV. 10-14 | 100.0 | 71.7 | 94.0 | 100.0 | 70.1 | 93.7 | 100.0 | 129.2 | 106.2 | 100.0 | 86.1 | 97.0 | 100.0 | 100.6 | 100.1 | 100.0 | 86.1 | 97.0 |
| 15 MECHANICAL | 100.0 | 55.8 | 80.5 | 100.0 | 48.7 | 77.3 | 100.1 | 119.4 | 108.6 | 99.8 | 85.6 | 93.5 | 100.6 | 94.1 | 97.7 | 99.8 | 85.6 | 93.5 |
| 16 ELECTRICAL | 93.3 | 65.4 | 74.7 | 90.2 | 40.8 | 57.2 | 109.7 | 128.8 | 122.5 | 85.2 | 78.7 | 80.9 | 87.5 | 92.2 | 90.6 | 85.7 | 79.4 | 81.5 |
| 1-16 WEIGHTED AVERAGE | 97.2 | 64.6 | 81.4 | 96.8 | 55.0 | 76.6 | 115.9 | 129.5 | 122.5 | 101.0 | 85.2 | 93.4 | 111.9 | 92.1 | 102.3 | 101.3 | 85.5 | 93.7 |

A.3.9-20

## ECO NUMBER 10

## USE AN ALTERNATIVE HEATING METHOD TO REDUCE SEP OPERATING COST

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-10
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-10 ALTERNATIVE HEATING METHODS FOR THE SEP
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT
A. CONSTRUCTION COST $ 6043.
B. SIOH $ 363.
C. DESIGN COST $ 363.
D. TOTAL COST (1A+1B+1C) $ 6769.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 6769.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 4. | 15.08 | $ 62. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 111. | $ 149. | 14.88 | $ 2213. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 111. | $ 153. | | $ 2275. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 10102.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 150318.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 150318.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 10255.

5. SIMPLE PAYBACK PERIOD (1G/4) .66 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 152593.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 22.54
(IF < 1 PROJECT DOES NOT QUALIFY)
**** Project does not qualify for ECIP funding; 4,5,6 for information only.

A.3.10-2

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-10
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-10 ALTERNATIVE HEATING METHODS FOR THE SEP
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION B
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT
A. CONSTRUCTION COST $ 334231.
B. SIOH $ 20054.
C. DESIGN COST $ 20054.
D. TOTAL COST (1A+1B+1C) $ 374339.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 374339.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ -5. | 15.08 | $ -83. |
| B. DIST | $ 4.40 | -9218. | $ -40559. | 18.57 | $ -753184. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 24711. | $ 33113. | 14.88 | $ 492718. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 15493. | $ -7452. | | $ -260550. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 12672.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 188559.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 188559.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 5220.

5. SIMPLE PAYBACK PERIOD (1G/4) 71.71 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ -71990.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= -.19
(IF < 1 PROJECT DOES NOT QUALIFY)

*** Project does not qualify for ECIP funding; 4,5,6 for information only.

WITH ECO'S 9A, 12A & 12B

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: ECO-10XY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-10 ALTERNATIVE HEATING METHODS FOR THE SEP
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 05-06-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT
A. CONSTRUCTION COST $ 6043.
B. SIOH $ 363.
C. DESIGN COST $ 363.
D. TOTAL COST (1A+1B+1C) $ 6769.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 6769.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 0. | 15.08 | $ 0. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 0. | $ 0. | | $ 0. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 10070.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 149842.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 149842.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 10070.

5. SIMPLE PAYBACK PERIOD (1G/4) .67 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 149842.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 22.14
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

**RS&H**

SUBJECT Fort Stewart
Send HTW from CEP to SEP
DESIGNER G. Fallon
CHECKER

AEP NO 694 1331 002
SHEET ____ OF ____
DATE 2-7-96
DATE

ECO No. 10 - A DISTRIBUTE HTW FROM CEP TO SEP INSTEAD OF STEAM.

THE HTW SYSTEM OPERATES AT THE SAME TEMPERATURE AS THE STEAM LINE, 375 °F. IF THE STEAM LINE WERE USED TO CONVEY HTW TO THE SEP THE HEAT LOSS FROM THE LINE WOULDN'T CHANGE. THEREFORE THERE WOULD BE NO ENERGY SAVINGS, BUT THERE WOULD BE A SIGNIFICANT DECREASE IN HEATING SEASON OPERATING LABOR.

ENERGY LOSS IN STEAM LINE

ENERGY LOSS DATA FROM SEP TEST SHOWS 3.66 MBTU/HR IN 8750 FT OF PIPE. See Calculation in ECO-12.

$$\text{STEAM LINE LOSS} = 3.66\ \text{MBTU/HR} \times \frac{5280\ \text{ft}}{8760\ \text{ft}} = 2.2\ \text{MBTU/HR}$$

MAX ENERGY REQ'T TO SEP

SEP LOAD = 25.46 MBTU/HR
LINE LOSS TO SEP = 2.2 MBTU/HR
TOTAL ENERGY REQ'T. 27.66 MBTU/HR.

JUMPER LINE SIZE IN CEP

$$\frac{27.66\ \text{MBTU/HR}}{500\ \frac{\text{PPH}}{\text{gpm}} \times (375-230)} = 382\ \text{gpm} \Rightarrow 4''\ \phi\ \text{PIPE}.$$

RETURN LINE ΔP

@ 382 gpm ΔP IN 4" LINE = 8ft/100FT pipe. (WORST CASE)

$$\frac{8\ \text{FT}}{100\ \text{FT}} \times 5280\ \text{FT} = 422\ \text{FT}$$

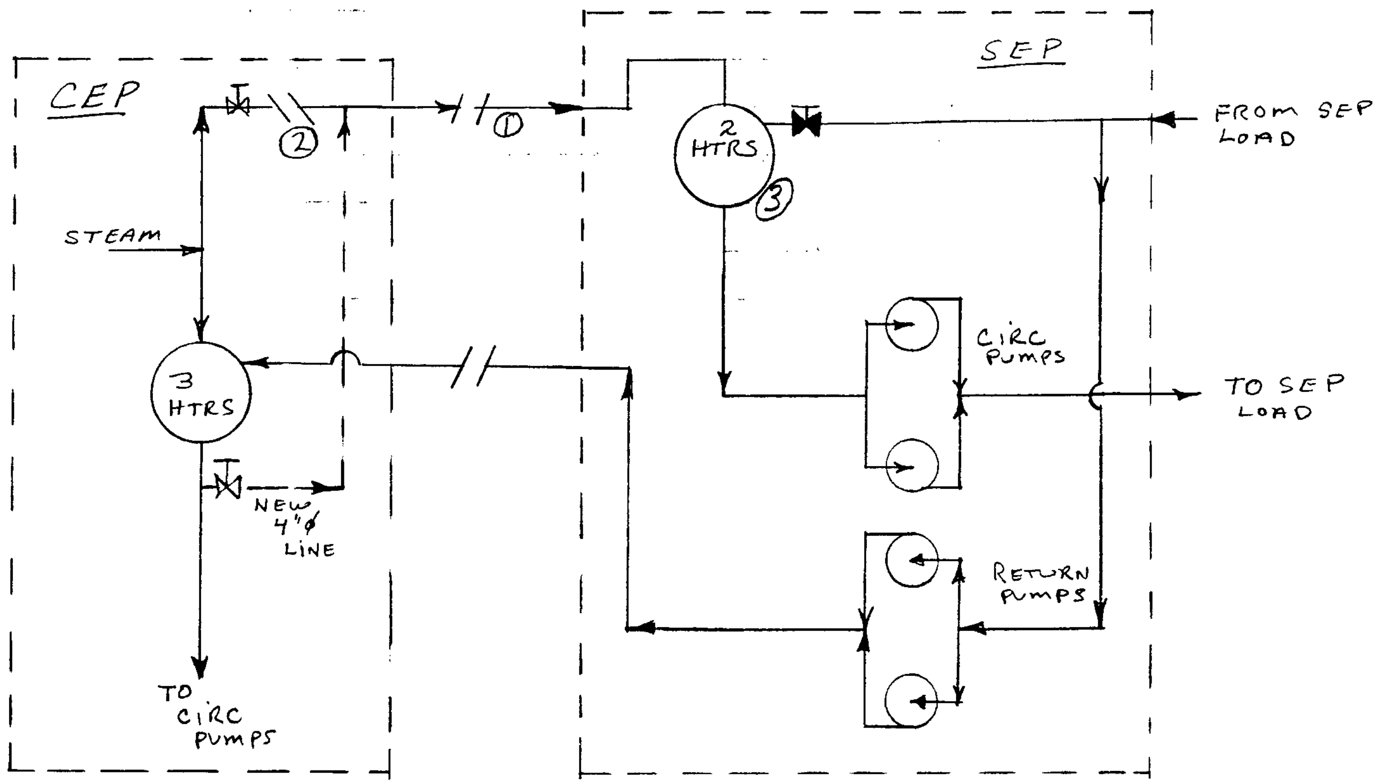
RS&H

SUBJECT Fort Stewart
HTW from CCP to SEP
DESIGNER G. Fallon
CHECKER

AEP NO 694 1331 002
SHEET OF
DATE 2-7-96
DATE

ECO-10-A

Schematic Diagram




① DISCONNECT STEAM TRAPS; OR, HEAVILY THROTTLE TRAP ISOLATION VALVES TO MINIMIZE, BUT NOT STOP, FLOW THROUGH TRAPS. MINIMAL TRAP FLOW WILL PROTECT DRIP LINE FROM FREEZING.

② BREAK & BLANK EXISTING STEAM LINE AT HEADER.

③ OPERATE HEATERS FULL

Proposed Labor Costs:

Start-up & shut down: assume 50%; $(\$2069+\$621)/YR \times 0.5 = \$1345/YR$ (see next page)

Operating Labor Costs $= 1\ \frac{trip}{day} \times \frac{1}{2}\ \frac{hr}{trip} \times \$25.86/hr \times 135\ \frac{day}{yr} = \$1746/YR$

O&M Savings $= \$10473/YR - \$1746/YR + \$1345/YR = \boxed{\$10{,}072/YR}$

**RS&H**

SUBJECT: FORT STEWART
AEP NO: 694 1331 002
SHEET ____ OF ____
DESIGNER: W. Todd
DATE: 2-1-96
CHECKER: ____
DATE: ____

ECO-10

## Satellite Energy Plant, Operating Costs - Labor

Assumptions:

1) SEP operates for $4\frac{1}{2}$ months / year
2) SEP startup takes 10 days / year
3) SEP shut down takes 3 days / yr
4) Normal operation requires one visit per shift that takes about 1 hour / visit.
5) Start-up and shut-down requires one operator Full time for one shift each day.

Pipefitters hourly rate w/ benefits = \$46.35 MMp 475

Adjusted for Savannah GA = \$46.35 × 0.558 = \$25.86 MMp 533

Labor Costs:

Startup: $10 \frac{days}{yr} \times 8 \frac{hrs}{day} \times \$25.86/hr = \underline{\$2069/YR}$

Operation: $4.5 \frac{mo}{YR} \times 30 \frac{day}{mo} \times 3 \frac{hr}{day} \times \$25.86/hr = \underline{\$10473/YR}$

Shut down: $3 \frac{day}{YR} \times 8 \frac{hr}{day} \times \$25.86/hr = \underline{\$621/YR}$

Total Labor Cost = \$1034/YR + \$9310/YR + \$621/YR = \underline{\$13163/YR}

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. | |
| AEP Number: | 694-1331-002 | Designer: | W. T. Todd |
| Project: | Distribute HTW from the CEP to the SEP | Date: | 02/12/96 |
| ECO Number: | 10 | | |

Assumptions:

| | | | |
|---|---|---|---|
| 1. | HTW temperature | 380 | °F |
| 2. | Make-up water temperature | 70 | °F |
| 3. | Boiler efficiency | 68% | |
| 4. | Pump head (from record drawings) | 300 | Ft H20 |
| 5. | Pump efficiency (from record drawings | 72% | |
| 6. | Motor efficiency | 90% | |
| 7. | Average heating fuel cost | $1.34 | /MBtu |
| 8. | Electricity cost | $0.0469 | /kWh |
| 9. | Water cost | $0.5562 | /kGallons |

Energy Use Calculations:

Energy Use = flow rate x specific heat x average temperature difference

58094 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 155 °F = 75.1 MBtu/Yr

Heating Fuel Use = 75.1 MBtu/yr / 0.68 = $\boxed{\text{110.5 MBtu/Yr}}$

Heating Fuel Cost = 110.5 MBtu/yr x $1.34 /MBtu = $148 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$\text{BHP} = \frac{3.67 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.39 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency ) x 0.746 kW/HP x Hr/Yr

Electric Demand = 0.39 BHP / 0.90 x 0.746 kW/HP = 0.32 kW

Electricity Use = 0.32 kW x 264 Hr/Yr = 84 kWh/Yr

Electricity Use = 84 kWh/Yr x 0.003413 MBtu/kWh = $\boxed{\text{0.3 MBtu/Yr}}$

Electricity Cost = 84 kWh/Yr x $0.0469 /kWh = $4 /Year

Water Cost:

58094 Gal/Yr x $0.5562 /kGal = $\boxed{\text{\$32 /Year}}$

Total Utility Cost:

| | | |
|---|---|---|
| Heating Fuel Cost | $148 | /Year |
| Pumping (Elec) Cost | $4 | /Year |
| Water Cost | $32 | /Year |
| Total Utility Cost | $184 | /Year |

# CONSTRUCTION COST ESTIMATE

Project: Distribute HTW instead of steam to SEP
Location: Fort Stewart, GA
Basis: Schematic Design
ECO No.: 10A

RS&H No.: 694-1331-002
Date: 02/14/96
Estimator: G. W. Fallon
Filename: EST-10A.WB2

| ITEM DESCRIPTION | QUANTITY No. | QUANTITY Unit | MATERIAL/EQUIP $/Unit | MATERIAL/EQUIP Total | LABOR $/Unit | LABOR Total | TOTAL COST | SOURCE Material | SOURCE Labor |
|---|---|---|---|---|---|---|---|---|---|
| Sch. 40 steel pipe, 4" | 100 | LF | 12.75 | 1275 | 12.79 | 1279 | 2,554 | MMp140 | MMp140 |
| Insul., 2" CalSil w/cover | 100 | LF | 6.75 | 675 | 3.58 | 358 | 1,033 | MMp236 | MMp236 |
| Flange, 300lb, weld nk | 4 | Ea | 25 | 100 | 48.75 | 195 | 295 | MMp165 | MMp165 |
| Sch. 40 elbow | 6 | Ea | 17.5 | 105 | 97 | 582 | 687 | MMp159 | MMp159 |
| Weldolet Connection, 4" | 2 | Ea | 46.75 | 94 | 72 | 144 | 238 | MMp163 | MMp163 |
| Gate Valve, 4", 300 lb | 1 | Ea | 1100 | 1100 | 32.50 | 33 | 1,133 | MMp197 | MMp197 |
| Subtotal Bare Costs | | | | 3349 | | 2591 | $5,940 | | |
| Retrofit Cost Factors | | | 0% | 0 | 0% | 0 | 0 | MMp6 | MMp6 |
| Subtotal | | | | 3349 | | 2591 | 5,940 | | |
| City Cost Index (Sav. GA) | | | 0% | 0 | -44% | -1145 | (1,145) | MMp533 | MMp533 |
| Subtotal | | | | 3349 | | 1446 | 4,795 | | |
| OH & Profit Markups | | | 10% | 335 | 53% | 766 | 1,101 | MMp7 | MMp475 |
| Subtotal | | | | 3684 | | 2212 | 5,896 | | |
| Sales Taxes | | | 4.0% | 147 | | NA | 147 | MMp476 | |
| Total Construction Cost | | | | 3831 | | 2212 | 6,043 | | |
| Design Fee | | | | NA | 6.0% | 363 | 363 | | |
| SIOH | | | | NA | 6.0% | 363 | 363 | | |
| Subtotal | | | | 3831 | | 2938 | 6,769 | | |
| Contingency | | | 0% | 0 | 0% | 0 | 0 | MEp6 | MEp6 |
| Total Project Cost | | | | 3831 | | 2938 | $6,769 | | |

LEGEND:
MMp### 1996 Means Mechanical Cost Data, page ###.

RS&H

| | | | |
|---|---|---|---|
| SUBJECT | FORT STEWART / SHUT DOWN THE SEP | AEP NO | 694 1331 002 |
| DESIGNER | W. TODD | SHEET | 1 OF |
| | | DATE | 2-7-96 |
| CHECKER | | DATE | |

ECO-10-B SHUT DOWN THE SEP

## SEP - Estimated Building Loads

Assumptions:

1) 2" diameter HTW supply pipe to building
2) Flow based on pipe friction pressure drop of 3ft/100 ft which is in the upper end of general design range.
3) The HTW temperature difference across the heat exchanger is ~ $180° - 60° = 120°F$

Heating Load:

Load = Flow × specific heat × temp. diff.

Flow ≈ 40 gal/min from ASHRAE Friction Loss chart

$$40 \frac{gal}{min} \times 8.34 \frac{lb}{gal} \times 60 \frac{min}{hr} \times 1 \frac{Btu}{lb\,°F} \times 120°F = 2401920 \frac{Btu}{hr}$$

$$2401920 \frac{Btu}{hr} \times 1\ MBtu/10^6\ Btu = 2.4\ MBtu/hr \text{ per bldg.}$$

The cost estimate is based on 5 boilers of this size.

## Heat Loss from HTW Piping

Assumptions:

1) Average HTW and steam pipe size is 6" dia.
2) Heat loss from dry insulated pipes is ~55 Btu/HR·FT
3) Heat loss from pipes with deteriorated and moist insulation is 275 Btu/HR·FT
4) Source is Ft. McClellan study (see attached pages)
5) Length of SEP piping is 17500 feet.
6) 50% of the sep piping is dry w/good insulation.

RS&H

| | | | |
|---|---|---|---|
| SUBJECT | FORT STEWART | AEP NO | 694 1331 002 |
| | SHUT DOWN THE SEP | SHEET | 2 OF |
| DESIGNER | W. TODD | DATE | 2-7-96 |
| CHECKER | | DATE | |

ECO-10-B

Heat Loss from HTW/steam piping (continued)

Current Heat Loss:

$$17500 \text{ LF} \times 0.5 \times 55 \text{ Btu/HR}\cdot\text{LF} \times \frac{1 \text{ mBtu}}{10^6 \text{ Btu}} = 0.481 \text{ mBtu/HR}$$

$$17500 \text{ LF} \times 0.5 \times 275 \text{ Btu/HR}\cdot\text{LF} \times \frac{1 \text{ mBtu}}{10^6 \text{ Btu}} = 2.406 \text{ mBtu/HR}$$

$$\text{Annual heat loss} = (0.481 + 2.406)\frac{\text{mBtu}}{\text{HR}} \times 135 \frac{\text{day}}{\text{YR}} \times 24 \frac{\text{hr}}{\text{day}} = 9354 \frac{\text{mBtu}}{\text{YR}}$$

$$\text{Annual Fuel Use} = 9354 \frac{\text{mBtu}}{\text{YR}} \div 0.68 = \underline{13756 \frac{\text{mBtu}}{\text{YR}}}$$

Operating Energy Costs:

The operating energy use will be the same for both systems, however, the cost of fuel oil is \$4.40/mBtu and the cost of CEP fuels (average) is \$1.34/mBtu.

Bin temperature data was used to estimate the heating energy used in the 5 buildings (see attached table)

Current Energy Cost (CEP HEATING FUELS):

$$7374 \text{ mBtu/YR} \div 0.68 = \underline{10844 \frac{\text{mBtu}}{\text{YR}}} \times \$1.34/\text{mBtu} = \$14531/\text{YR}$$

Proposed Energy Cost (FUEL OIL NO. 2):

$$7374 \frac{\text{mBtu}}{\text{YR}} \div 0.80 = \underline{9218 \frac{\text{mBtu}}{\text{YR}}} \times \$4.40/\text{mBtu} = \$40,557/\text{YR}$$

ECO-10-B

O&M Costs for new boilers

Assume 1 hour per month per boiler for maintenance.

$$1 \frac{HR}{MO} \times 4 \frac{MO}{YR} \times 5 \text{ BOILERS} \times \$25.86/HR = \underline{\$517/YR}$$

Pumping Energy

Assume the new circulating pumps will be the same size at the existing HHW circ. pumps in the buildings.

SEP Zone HTW Pump:

$$\text{Heating energy} = 7374 \frac{mBtu}{YR} \times \frac{1\,YR}{135\,day} \times \frac{1\,day}{24\,HR} \times \frac{1\,HR}{60\,min} = 37932 \frac{Btu}{HR}$$

$$lb/HR = \frac{37932 \frac{Btu}{HR}}{1 \frac{Btu}{lb\,°F} \times 120\,°F} = 316 \frac{lb}{HR} \times \frac{1\,GAL}{8.34\,lb} \times \frac{1\,HR}{60\,min} = 0.63\ GPM$$

$$BHP = \frac{0.63 \times 300'HD}{3960 \times 0.72} = 0.07\ BHP \div 0.9 \times 0.746 \frac{KW}{BHP} = 0.06\ KW$$

$$0.06\ KW \times 135 \frac{day}{YR} \times 24 \frac{HR}{day} \times 3413 \frac{Btu}{KWH} \times \frac{1\,mBtu}{10^6\,Btu} = \underline{0.7\ mBtu/YR}$$

RS&H

SUBJECT FORT STEWART
SHUT DOWN SEP
DESIGNER W. TODD
CHECKER

AEP NO 694 1331 002
SHEET ____ OF ____
DATE 2-7-96
DATE

ECO-10 B

ANNUAL SAVINGS (INCREASE)

HEATING FUELS = 111 + 13756 + 10844 = $\boxed{24711 \frac{\text{MBtu}}{\text{YR}}}$

ELECTRICITY = 0.3 - 0.7 = $\boxed{(0.4)\ \text{MBtu/YR}}$

FUEL OIL = $\boxed{(9218)\ \text{MBtu/YR}}$

WATER = $\boxed{\$32/\text{YR}}$

O&M = 13163 - 517 = $\boxed{\$12,646/\text{YR}}$

# CONSTRUCTION COST ESTIMATE

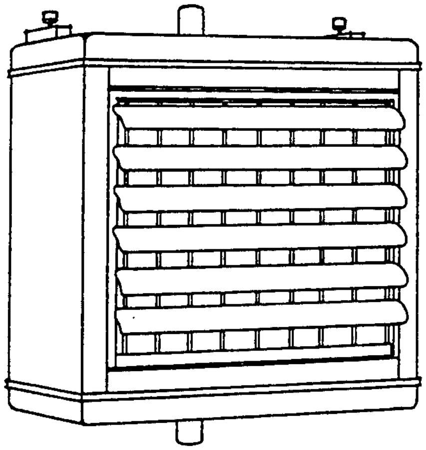
Project: Shut Down SEP, Install Small Boilers
Location: Fort Stewart, GA
Basis: Schematic Design
ECO No.: 10B

RS&H No.: 694-1331-002
Date: 02/14/96
Estimator: W.T.Todd
Filename: EST-10B.WB2

| ITEM DESCRIPTION | QUANTITY No. | QUANTITY Unit | MATERIAL/EQUIP $/Unit | MATERIAL/EQUIP Total | LABOR $/Unit | LABOR Total | TOTAL COST | SOURCE Material | SOURCE Labor |
|---|---|---|---|---|---|---|---|---|---|
| Hydronic Heating with | 5 | Ea | 47664 | 238320 | 20853 | 104265 | 342,585 | MMp370 | MMp370 |
| Boiler, oil fired, 2.4 MB | | | | | | | | MMp370 | MMp370 |
| Circulating pump | | | | | | | | MMp370 | MMp370 |
| Expansion tank | | | | | | | | MMp370 | MMp370 |
| Oil tank, above ground | | | | | | | | MMp370 | MMp370 |
| Valves and fittings | | | | | | | | MMp370 | MMp370 |
| Boiler Breeching | | | | | | | | MMp370 | MMp370 |
| Fuel oil piping system | | | | | | | | MMp370 | MMp370 |
| Sch 40 steel pipe | | | | | | | | MMp370 | MMp370 |
| Insul., Cal.Sil., 1" wall | | | | | | | | MMp370 | MMp370 |
| Boiler Shed, 20' x 8' | 5 | Ea | 5200 | 26000 | 415 | 2075 | 28,075 | MMp10 | MMp10 |
| Subtotal Bare Costs | | | | 264320 | | 106340 | $370,660 | | |
| Retrofit Cost Factors | | | 0% | 0 | 0% | 0 | 0 | MMp6 | MMp6 |
| Subtotal | | | | 264320 | | 106340 | 370,660 | | |
| City Cost Index (Sav. GA) | | | 0% | 0 | -44% | -47002 | (47,002) | MMp533 | MMp533 |
| Subtotal | | | | 264320 | | 59338 | 323,658 | | |
| OH & Profit Markups | | | 0% | 0 | 0% | 0 | 0 | Included | Included |
| Subtotal | | | | 264320 | | 59338 | 323,658 | | |
| Sales Taxes | | | 4.0% | 10573 | | NA | 10,573 | MMp476 | |
| Total Construction Cost | | | | 274893 | | 59338 | 334,231 | | |
| Design Fee | | | | NA | 6.0% | 20054 | 20,054 | | |
| SIOH | | | | NA | 6.0% | 20054 | 20,054 | | |
| Subtotal | | | | 274893 | | 99446 | 374,339 | | |
| Contingency | | | 0% | 0 | 0% | 0 | 0 | MEp6 | MEp6 |
| Total Project Cost | | | | 274893 | | 99446 | $374,339 | | |

LEGEND:
MMp### 1996 Means Mechanical Cost Data, page ###.

# HEATING | A8.3-141 | Hydronic, Fossil Fuel Boilers



Unit Heater

**Fossil Fuel Boiler System Considerations:**

1. Terminal units are horizontal unit heaters. Quantities are varied to accommodate total heat loss per building.
2. Unit heater selection was determined by their capacity to circulate the building volume a minimum of three times per hour in addition to the BTU output.
3. Systems shown are forced hot water. Steam boilers cost slightly more than hot water boilers. However, this is compensated for by the smaller size or fewer terminal units required with steam.
4. Floor levels are based on 10' story heights.
5. MBH requirements are gross boiler output.

| System Components | QUANTITY | UNIT | COST EACH MAT. | COST EACH INST. | COST EACH TOTAL |
|---|---|---|---|---|---|
| SYSTEM 8.3-141-1280 | | | | | |
| HEATING SYSTEM, HYDRONIC, FOSSIL FUEL, TERMINAL UNIT HEATERS | | | | | |
| CAST IRON BOILER, GAS, 80 MBH, 1,070 S.F. BUILDING | | | | | |
| Boiler, gas, hot water, CI, burner, controls & insulation 80 MBH | 1.000 | Ea. | 1,300 | 970 | 2,270 |
| Pipe, steel, black, schedule 40, threaded, cplg & hngr 10'OC, 2" diam | 50 ~~200.000~~ | L.F. | 247 ~~988~~ | 518 ~~2,070~~ | ~~3,058~~ |
| Unit heater, 1 speed propeller, horizontal, 200° EWT, 72.7 MBH | 2.000 | Ea. | 0 ~~1,900~~ | 0 ~~191~~ | ~~2,091~~ |
| Unit heater piping hookup with controls | 2.000 | Set | 0 ~~640~~ | 0 ~~1,580~~ | ~~2,220~~ |
| Boiler breeching | 1.000 | System | 65 | 48.50 | 113.50 |
| Expansion tank, painted steel, ASME, 18 Gal capacity | 1.000 | Ea. | 1,250 | 55.50 | 1,305.50 |
| Circulating pump, CI, flange connection, 1/12 HP | 1.000 | Ea. | 198 | 110 | 308 |
| Pipe covering, calcium silicate w/cover, 1" wall, 2" diam | 50 ~~200.000~~ | L.F. | 145 ~~580~~ | 209 ~~836~~ | ~~1,416~~ |
| TOTAL | | | 3205 ~~6,921~~ | 1911 ~~5,861~~ | 5116 ~~12,782~~ |
| COST PER S.F. | | | ~~6.47~~ 0.463 | ~~5.48~~ 0.326 | ~~11.95~~ |

| 8.3-141 | Heating Systems, Unit Heaters | | COST PER S.F. MAT. | COST PER S.F. INST. | COST PER S.F. TOTAL |
|---|---|---|---|---|---|
| 1260 | Heating systems, hydronic, fossil fuel, terminal unit heaters, | | | | |
| 1280 | Cast iron boiler, gas, 80 M.B.H., 1,070 S.F. bldg. | | 6.45 | 5.50 | 11.95 |
| 1320 | 163 M.B.H., 2,140 S.F. bldg. | R155 -010 | 4.41 | 3.72 | 8.13 |
| 1360 | 544 M.B.H., 7,250 S.F. bldg. | | 3.04 | 2.58 | 5.62 |
| 1400 | 1,088 M.B.H., 14,500 S.F. bldg. | R155 -020 | 2.71 | 2.46 | 5.17 |
| 1440 | 3,264 M.B.H., 43,500 S.F. bldg. | | 2.29 | 1.84 | 4.13 |
| 1480 | 5,032 M.B.H., 67,100 S.F. bldg. | R155 -030 | 2.48 | 1.91 | 4.39 |
| 1520 | Oil, 109 M.B.H., 1,420 S.F. bldg. | | 6.40 | 4.87 | 11.27 |
| 1560 | 235 M.B.H., 3,150 S.F. bldg. | | 4.24 | 3.52 | 7.76 |
| 1600 | 940 M.B.H., 12,500 S.F. bldg. | | 3.20 | 2.25 | 5.45 |
| 1640 | 1,600 M.B.H., 21,300 S.F. bldg. | | 3.10 | 2.14 | 5.24 |
| 1680 | 2,480 M.B.H., 33,100 S.F. bldg. | $3.10 \times .463 = 1.44$ ; $1.94 \times .326 = 0.63$ | 1.44 ~~3.10~~ | 0.63 ~~1.94~~ | ~~5.04~~ |
| 1720 | 3,350 M.B.H., 44,500 S.F. bldg. | | 2.74 | 1.99 | 4.73 |
| 1760 | Coal, 148 M.B.H., 1,975 S.F. bldg. | Mat = $1.44 \times 33100$ = 47644 | 4.70 | 3.20 | 7.90 |
| 1800 | 300 M.B.H., 4,000 S.F. bldg. | | 3.68 | 2.50 | 6.18 |
| 1840 | 2,360 M.B.H., 31,500 S.F. bldg. | Lab = $0.63 \times 33100$ = 20853 | 2.69 | 2.01 | 4.70 |
| 1880 | Steel boiler, gas, 72 M.B.H., 1,020 S.F. bldg. | | 5.85 | 4.06 | 9.91 |
| 1920 | 240 M.B.H., 3,200 S.F. bldg. | | 4.18 | 3.22 | 7.40 |
| 1960 | 480 M.B.H., 6,400 S.F. bldg. | | 3.39 | 2.38 | 5.77 |
| 2000 | 800 M.B.H., 10,700 S.F. bldg. | | 2.99 | 2.13 | 5.12 |
| 2040 | 1,960 M.B.H., 26,100 S.F. bldg. | | 2.69 | 1.91 | 4.60 |
| 2080 | 3,000 M.B.H., 40,000 S.F. bldg. | | 2.66 | 1.95 | 4.61 |





A.3.10-15

rS

| To →/ From ↓ | ΔP | | | | ΔP/L | | | ΔP/ϱ | | ΔP/ϱL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | psi | psf | Pa | kPa | (psi/ 100 ft) | (Pa/ m) | (kPa/ m) | ft (1) | (J/ kg) | (ft/ 100 ft) | (milinch/ ft) | (J/ kg m) |
| psi | 1 | 144 | 6890 | 6.89 | — | — | — | — | — | — | — | — |
| psf | 0.00694 | 1 | 4.79 | 0.00479 | — | — | — | — | — | — | — | — |
| Pa | 0.000145 | 0.209 | 1 | 0.001 | — | — | — | — | — | — | — | — |
| kPa | 0.145 | 209 | 1000 | 1 | — | — | — | — | — | — | — | — |
| (psi/ 100 ft) | — | — | — | — | 1 | 226 | 0.226 | — | — | — | — | — |
| (Pa/ m) | — | — | — | — | 0.00442 | 1 | 0.001 | — | — | — | — | — |
| (KPa/ m) | — | — | — | — | 4.42 | 1000 | 1 | — | — | — | — | — |
| ft (1) | — | — | — | — | — | — | — | 1 | 3.00 | — | — | — |
| (J/ kg) | — | — | — | — | — | — | — | 0.344 | 1 | — | — | — |
| (ft/ 100 ft) | — | — | — | — | — | — | — | — | — | 1 | 120 | 0.0983 |
| (milinch/ ft) | — | — | — | — | | — | — | — | — | 0.00833 | 1 | 0.000819 |
| (J/ kg m) | — | — | — | — | — | — | — | — | — | 10.2 | 1220.7 | 1 |

(1) (ft-lb/lb) = ft

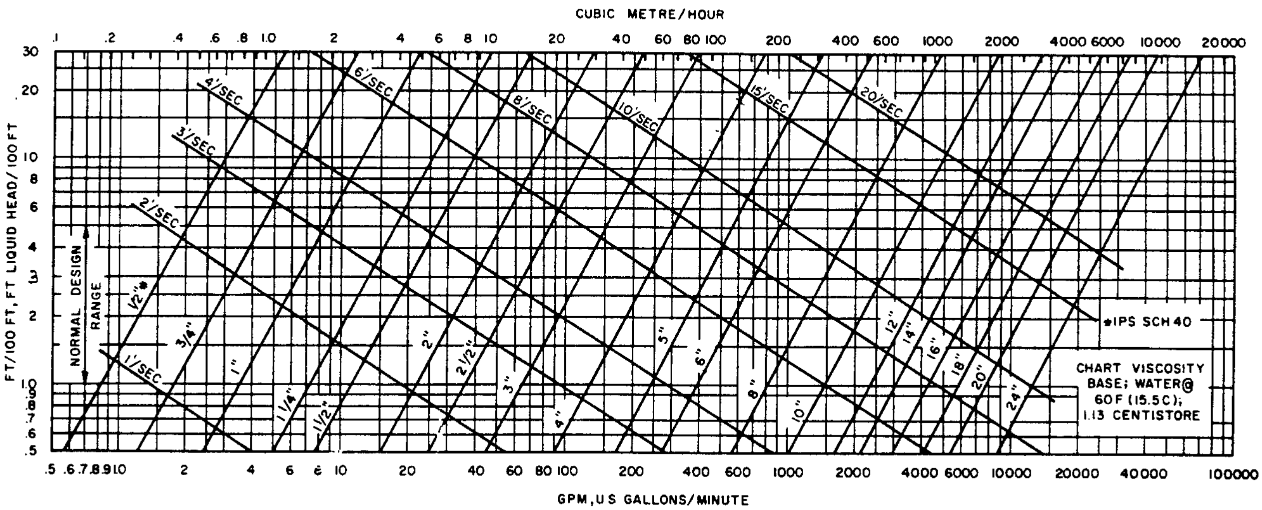



**Fig. 1 Friction Loss for Water in Commercial Steel Pipe (Schedule 40)**

system must be equipped with air separation devices to minimize the amount of entrained air in the piping circuit. Air should be vented at the highest point of the sytem.

In the absence of such venting, air can be entrained in the water and carried to separation units at flow velocities of 1.5 to 2 fps or more in pipe sizes 2 in. and under. Minimum velocities of 2 fps are therefore recommended. For pipe sizes 2 in. and over, minimum velocities corresponding to .75 ft/100 ft (.75 m/100 m) are normally used. Particular attention to maintenance of minimum velocities should be observed in the upper floors of high rise buildings when the air may tend to come out of solution because of the reduced pressures. Higher velocities should be used in *down-comer* return mains feeding into air separation units located in the basement.

*Example 1:* Determine pipe size for circuit requiring 20 gpm flow.
*Solution:* Enter Fig. 1 at 20 gpm, read up to pipe size within normal design range, select 1 1/2 in. Velocity is 3.1 fps which is between 2-4. Pressure loss is 2.9 ft/100 ft which is between 1-4 ft/100 ft.

## Valve and Fitting Pressure Drop

Valve and fitting pressure drop is usually listed in elbow equivalents. The elbow equivalent simply relates pressure drop through a valve or fitting to an equivalent pipe length. The pressure drop of one elbow is approximately the same as that of a length of straight pipe 25 times the pipe diameter. The following simple rule-of-thumb is often used: the equivalent length of pipe in feet for an elbow equals 2 times nominal pipe diameter (inches). Thus, a 1-in. elbow = 2 equivalent ft of 1-in. pipe, a 4-in. elbow = 8 equivalent ft of 4-in. pipe, etc.

2.7

A more accurate determination, related to water flow velocity, is listed in Table 2.

Elbow equivalents for valves and fittings for iron and copper are shown in Table 3.

*Example 2*: Determine equivalent feet of pipe for a 4-in. open gate valve at a flow velocity of approximately 4 fps.
*Solution*: From Table 2, at 4 fps, each equivalent elbow is equal to 10.6 ft of 4-in. pipe. From Table 3, the 4-in. gate valve is equal to 0.5 elbows. The actual equivalent pipe length (added to measure circuit length for pressure drop determination) will be 10.6 × 0.5, or 5.3 equivalent feet of 4-in. pipe.

*Tee Fitting Pressure Drop.* Pressure drop through pipe tees varies with flow through the branch. Pressure drops are illustrated in Fig. 3 for tees of equal inlet and outlet sizes, and for the flow patterns illustrated.

A.3.10-16

CONF-8406132--2



# ANALYSIS OF A SMALL DISTRICT STEAM SYSTEM AT FT. McCLELLAN, ALABAMA

CONF-8406132

DE84 014051

Gerald D. Pine and Michael A. Karnitz

Energy Division
Oak Ridge National Laboratory*
Oak Ridge, Tennessee 37831

615 576-5454

574-5150

For presentation at the
75th Annual Conference of the International
District Heating Association
Mount Washington, New Hampshire

June 17-20, 1984

MASTER



*Research sponsored by the U. S. Army, Construction Engineering Research Laboratory, under Interagency Agreement Number 40-1361-83, Army Number CERL-83-080, operated by Martin Marietta Energy Systems, Inc., under Contract No. DE-AC05-84OR21400 with the U.S. Department of Energy.



A.3.10-17

Of the total steam produced, we estimate that approximately 95% enters the steam distribution system. The remaining 5% is used within the boiler plants to power auxiliaries. This amounts to some 570 lb/hr on the average or 5.0 million lb/yr. Then approximately 96 million lb/yr enters the distribution system.

## 5. CAUSES FOR HEAT LOSS FROM BURIED PIPE

In order to minimize heat losses from steam and condensate pipe lines, the lines are usually insulated. Sometimes the pipes may run above ground but more commonly, the pipes are buried from two to six feet below the surface. If the insulation is intact and dry, the ground helps to insulate the pipe from cold temperatures in the winter and to reduce the heat losses. In this section, we present estimates of the heat losses for well insulated pipes as well as for pipes with deteriorated insulation and under various failure conditions.

Heat Loss From Dry, Insulated, Buried Pipes. Heat losses have been calculated for varied soil conditions and various types of insulation by King et. al. [3]. For the example of a six-inch steam line at 325°F with four inches of calcium silicate insulation in clay of average moisture and a soil temperature of 50°F, the rate of heat loss would be approximately 55 Btu/hour per linear foot of pipe. For the Ft. McClellan system with a steam temperature of 338°F and a ground temperature of 80°F, the loss rate would be about 52 Btu/hr-ft.

Heat Loss From Bare Pipes in Air. The simplest case to consider is a bare pipe exposed to ambient air on a dry, still day. For this case, the two major heat loss mechanisms are natural convection and radiation. We consider the case of a six-inch pipe with 338°F steam and ambient air at 150°F (a typical temperature inside a dry vault, where much of the bare pipe is found). The estimated loss due to natural convection under these conditions is about 350 Btu/hour per foot of pipe. Kreith [4] in Table 5.1 gives a value of emissivity of 0.8 for oxidized steel pipe. For the same pipe, the estimated radiation loss is approximately 570 Btu/hr-ft. The total loss per foot of bare pipe under these circumstances is then 920 Btu/hr-ft.

Buried Pipes With Entrapped Moisture and Deteriorated Insulation. Observations of actual buried steam lines indicates that the heat losses are substantially higher than the theoretical losses. Consideration of the magnitudes of the observed losses suggests that the pipe is behaving as though there were no insulation, and that the pipe is in direct contact with the surrounding soil. The most likely physical explanation is that the conductivity has been greatly enhanced by the deterioration of the insulation from the combined effects of heat and moisture that gets into the system by steam leaks or the intrusion of ground water. Entrapped moisture could be boiling near the surface of the pipe and condensing on the jacket, or subcooled boiling and the formation of a thermal convection loop in water filling the space between the pipe and jacket could be occurring. Both these processes produce extremely high heat transfer rates compared to the rate through dry insulation. If it is assumed that the conductivity of the insulation is infinite, the model of King et al. yields a heat transfer factor of about 1.8 Btu/hr-°F per foot of six-inch diameter pipe. For the six-inch pipe at 338°F and a 80°F ground temperature, the rate of heat loss per foot of pipe would be 460 Btu/hr-ft. This compares with the observed value of about 275 Btu/hr-ft.

Heat Loss From Flooding of Vaults. A commonly observed failure of steam lines is the failure of sump pumps in valve pits and the subsequent covering of the steam pipe with water. The source of the water can be either condensate from steam traps, which collects in the vault and causes flooding when sump pumps fail, or intrusion of ground water into the pits through cracks in the pit wall or around pipes that penetrate the pit walls. Water in the vaults is commonly heated to temperatures that are rather hot; we assume here that the water in the vault is heated to 150°F. The estimated rate of heat loss from a bare, six-inch steam pipe carrying 338°F steam and covered by 150°F water is 50,000 Btu/hr-ft. (This estimate could be higher, perhaps as high as 150,000 Btu/hr-ft depending on the assumed heat transfer mechanism.) Notice that the loss is nearly sixty times as large as the loss from dry, bare pipe. Perhaps even more interesting, the rate of heat loss would be 190 times greater than the

Fort Stewart – Central Energy Plant
Filename: FS-VPDIS.WQ1
12/15/95

Approximate Distance Between Valve Pits (1)

| ZONE 1 | | ZONE 2N | | ZONE 2S | | ZONE 3 | | SEP ZONE | | |
|---|---|---|---|---|---|---|---|---|---|---|
| PIT# | LN.FT. | PIT# | LN.FT. | PIT# | LN.FT. | PIT# | LN.FT. | PIT# | LN.FT. | |
| CP-B1 | 200 | CP-V1 | 150 | V1-B1 | 700 | CP-? | 700 | C1-V1 | 1500 | (2) |
| B1-V4 | 1000 | V1-V2 | 200 | B1-V1 | 1500 | ?-1 | 800 | V1-V2 | 100 | (2) |
| V1-V2 | 600 | V2-V3 | 350 | V1-B2 | 300 | ?-2 | 400 | V2-V3 | 1700 | (2) |
| V2-V3 | 200 | V3-V4 | 650 | B2-B3 | 550 | 2-2A | 400 | V3-V4 | 450 | (2) |
| V3-V4 | 350 | V4-V5 | 600 | B3-V1 | 250 | 2A-3 | 500 | V4-V5 | 600 | (2) |
| V4-V5 | 300 | V5-V6 | 800 | V1-V2 | 250 | 3-3A | 400 | V5-V6 | 500 | (2) |
| V5-V6 | 550 | V6-V7 | 800 | V1-V3 | 350 | 3A-6 | 550 | V6-SP | 100 | (2) |
| V6-V7 | 400 | V2-V8 | 750 | V3-V4 | 250 | 4-5 | 900 | SP-V7 | 200 | |
| V7-V8 | 600 | V8-V9 | 300 | V3-V6 | 300 | 5-6 | 650 | V7-V8 | 150 | |
| V8-V9 | 350 | | | V4-V5 | 200 | 6-7 | 850 | V8-V9 | 550 | |
| V9-V10 | 350 | | | V3-V7 | 650 | 7-8 | 950 | V9-V10 | 650 | |
| V10-V11 | 250 | | | V7-V8 | 250 | 8-9 | 1000 | V10-V11 | 800 | |
| V11-V12 | 500 | | | V8-V9 | 500 | 9-10 | 1000 | V11-V12 | 650 | |
| V12-V13 | 1000 | | | V9-V10 | 200 | 10-11 | 900 | V12-V13 | 800 | |
| V13-V14 | 350 | | | V9-V11 | 450 | 11-12 | 500 | | | |
| V14-V15 | 400 | | | | | 12-13 | 950 | | | |
| V15-V16 | 400 | | | | | 13-13A | 750 | | | |
| V16-V17 | 500 | | | | | 12-14 | 950 | | | |
| V17-V18 | 800 | | | | | 14-15 | 200 | | | |
| | | | | | | 15-16 | 250 | | | |
| | | | | | | 16-16A | 300 | | | |
| | | | | | | 16A-17 | 200 | | | |
| | | | | | | 17-18 | 200 | | | |
| | | | | | | 18-19 | 100 | | | |
| | | | | | | 19-20 | 150 | | | |
| | | | | | | 20-22 | 200 | | | |
| | | | | | | 21-22 | 100 | | | |
| | | | | | | 22-23 | 350 | | | |
| | | | | | | 15-24C | 350 | | | |
| | | | | | | 24C-24B | 200 | | | |
| | | | | | | 24B-24 | 200 | | | |
| | | | | | | 24-24A | 200 | | | |
| | | | | | | 24A-25 | 150 | | | |
| | | | | | | 24A-25A | 300 | | | |
| | | | | | | 25A-26 | 100 | | | |
| | | | | | | 26-26A | 200 | | | |
| | | | | | | 26A-27 | 250 | | | |
| | | | | | | 27-28 | 250 | | | |

| | ZONE 1 | ZONE 2N | ZONE 2S | ZONE 3 | SEP ZONE | |
|---|---|---|---|---|---|---|
| TOTAL LN.FT. | 9100 | 4600 | 6700 | 17400 | 8750 | |
| MILES | 1.7 | 0.9 | 1.3 | 3.3 | 1.7 | 8.8 |
| MAX LNFT/VP | 1000 | 800 | 1500 | 1000 | 1700 | |
| AVG LNFT/VP | 479 | 511 | 447 | 458 | 625 | 490 |
| MIN LNFT/VP | 200 | 150 | 200 | 100 | 100 | |
| NO. OF PITS (1) | 19 | 9 | 15 | 38 | 14 | 95 |

(1) There are other valve boxes and drain pits that are not shown on our HTW system map.

(2) These pipes carry steam.

# HEATING SEASON ENERGY CONSUMPTION FOR SEP BUILDINGS

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | SEP Building Number | 4502 | 4577 | 4578 | 4528 | 3002 | Total |
| | | | | | | | | Pipe size feeding building | 2"dia | 2"dia | 1.5"dia. | 1.25" dia. | 1" dia. | |
| | | | | | | | | GPM flow rate at 3 ft/100 ft | 40 | 40 | 20 | 13 | 7 | |
| | | | | | | | | Max Heat delivery (MBtu/Hr) | 2.4 | 2.4 | 1.2 | 0.8 | 0.4 | 7.21 |
| Temp. | Hours in Temperature Range | | | | | | | | | | | | | |
| Range | Nov | Dec | Jan | Feb | Mar | Total | Time (%) | Load (%) | MBTU | | | | | |
| 60/64 | 130 | 87 | 88 | 103 | 135 | 543 | 18.4% | 10.0% | 130 | 130 | 65 | 42 | 23 | 391 |
| 55/59 | 118 | 100 | 105 | 101 | 118 | 542 | 18.3% | 20.0% | 260 | 260 | 130 | 85 | 46 | 781 |
| 50/54 | 101 | 115 | 106 | 106 | 110 | 538 | 18.2% | 30.0% | 388 | 388 | 194 | 126 | 68 | 1,163 |
| 45/49 | 77 | 112 | 109 | 102 | 77 | 477 | 16.1% | 40.0% | 458 | 458 | 229 | 149 | 80 | 1,375 |
| 40/44 | 50 | 101 | 111 | 70 | 57 | 389 | 13.2% | 50.0% | 467 | 467 | 234 | 152 | 82 | 1,402 |
| 35/39 | 27 | 71 | 76 | 44 | 29 | 247 | 8.4% | 60.0% | 356 | 356 | 178 | 116 | 62 | 1,068 |
| 30/34 | 9 | 46 | 45 | 27 | 11 | 138 | 4.7% | 70.0% | 232 | 232 | 116 | 75 | 41 | 696 |
| 25/29 | 2 | 21 | 25 | 10 | 2 | 60 | 2.0% | 80.0% | 115 | 115 | 58 | 37 | 20 | 346 |
| 20/24 | 1 | 7 | 9 | 2 | | 19 | 0.6% | 90.0% | 41 | 41 | 21 | 13 | 7 | 123 |
| 15/19 | | 1 | 2 | 1 | | 4 | 0.1% | 100.0% | 10 | 10 | 5 | 3 | 2 | 29 |
| | | | | | Total | 2957 | 100.0% | | 2,458 | 2,458 | 1,229 | 799 | 430 | 7,374 |

## HUNTER AAF/SAVANNAH GEORGIA

| Temperature Range | NOVEMBER | | | | | DECEMBER | | | | | JANUARY | | | | | FEBRUARY | | | | | MARCH | | | | | APRIL | | | | | ANNUAL TOTAL | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Obsn Hour Gp | | | Total Obsn | MCWB | Obsn Hour Gp | | | Total Obsn | MCWB | Obsn Hour Gp | | | Total Obsn | MCWB | Obsn Hour Gp | | | Total Obsn | MCWB | Obsn Hour Gp | | | Total Obsn | MCWB | Obsn Hour Gp | | | Total Obsn | MCWB | Obsn Hour Gp | | | Total Obsn | MCWB |
| | 01 to 08 | 09 to 16 | 17 to 24 | | | 01 to 08 | 09 to 16 | 17 to 24 | | | 01 to 08 | 09 to 16 | 17 to 24 | | | 01 to 08 | 09 to 16 | 17 to 24 | | | 01 to 08 | 09 to 16 | 17 to 24 | | | 01 to 08 | 09 to 16 | 17 to 24 | | | 01 to 08 | 09 to 16 | 17 to 24 | | |
| 105/109 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 | | 0 | 79 |
| 100/104 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | 0 | 3 | 78 |
| 95/99 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 30 | 3 | 33 | 78 |
| 90/94 | | | | | | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 69 | | 1 | 0 | 1 | 73 | 0 | 157 | 23 | 180 | 77 |
| 85/89 | | 0 | | 0 | 70 | | | | | | | 0 | | 0 | 69 | | | | | | | 2 | 1 | 3 | 68 | | 8 | 1 | 9 | 69 | 3 | 390 | 90 | 483 | 75 |
| 80/84 | | 7 | 0 | 7 | 69 | | 1 | | 1 | 68 | | 1 | | 1 | 68 | | 3 | 0 | 3 | 66 | | 10 | 2 | 12 | 67 | | 33 | 5 | 38 | 68 | 56 | 454 | 272 | 782 | 73 |
| 75/79 | | 26 | 2 | 28 | 66 | | 6 | | 6 | 66 | | 7 | 1 | 8 | 66 | | 10 | 2 | 12 | 64 | 0 | 25 | 5 | 30 | 64 | 1 | 59 | 18 | 78 | 66 | 374 | 391 | 510 | 1275 | 71 |
| 70/74 | 1 | 45 | 11 | 57 | 63 | | 19 | 1 | 20 | 62 | 0 | 17 | 3 | 20 | 63 | 0 | 23 | 5 | 28 | 62 | 1 | 38 | 15 | 54 | 61 | 15 | 56 | 46 | 117 | 64 | 545 | 331 | 413 | 1289 | 68 |
| 65/69 | 21 | 49 | 45 | 115 | 61 | 8 | 31 | 17 | 56 | 61 | 4 | 27 | 11 | 42 | 60 | 6 | 36 | 19 | 61 | 60 | 21 | 44 | 38 | 103 | 60 | 51 | 42 | 71 | 164 | 61 | 351 | 289 | 349 | 989 | 62 |
| 60/64 | 38 | 44 | 48 | 130 | 57 | 18 | 40 | 29 | 87 | 56 | 19 | 37 | 32 | 88 | 57 | 30 | 35 | 38 | 103 | 57 | 40 | 45 | 50 | 135 | 56 | 65 | 27 | 52 | 144 | 58 | 341 | 263 | 322 | 926 | 57 |
| 55/59 | 38 | 34 | 46 | 118 | 53 | 24 | 40 | 36 | 100 | 52 | 28 | 39 | 38 | 105 | 52 | 28 | 36 | 37 | 101 | 52 | 39 | 34 | 45 | 118 | 52 | 45 | 11 | 26 | 82 | 53 | 274 | 206 | 259 | 739 | 52 |
| 50/54 | 44 | 20 | 37 | 101 | 48 | 29 | 40 | 46 | 115 | 47 | 30 | 37 | 39 | 106 | 47 | 32 | 32 | 42 | 106 | 47 | 45 | 23 | 42 | 110 | 47 | 28 | 4 | 15 | 47 | 48 | 244 | 160 | 239 | 643 | 48 |
| 45/49 | 39 | 10 | 28 | 77 | 43 | 36 | 33 | 43 | 112 | 43 | 32 | 35 | 42 | 109 | 43 | 38 | 25 | 39 | 102 | 43 | 35 | 15 | 27 | 77 | 43 | 25 | 1 | 6 | 32 | 44 | 227 | 120 | 192 | 539 | 43 |
| 40/44 | 31 | 4 | 15 | 50 | 39 | 42 | 22 | 37 | 101 | 38 | 45 | 25 | 41 | 111 | 38 | 35 | 13 | 22 | 70 | 39 | 35 | 7 | 15 | 57 | 38 | 9 | | 1 | 10 | 40 | 207 | 71 | 134 | 412 | 38 |
| 35/39 | 19 | 1 | 7 | 27 | 34 | 39 | 10 | 22 | 71 | 34 | 37 | 15 | 24 | 76 | 34 | 25 | 7 | 12 | 44 | 34 | 20 | 4 | 5 | 29 | 34 | 2 | | 0 | 2 | 36 | 145 | 37 | 70 | 252 | 34 |
| 30/34 | 7 | 0 | 2 | 9 | 30 | 30 | 5 | 11 | 46 | 29 | 28 | 5 | 12 | 45 | 29 | 19 | 3 | 5 | 27 | 30 | 9 | 0 | 2 | 11 | 30 | 0 | | | 0 | 33 | 93 | 13 | 32 | 138 | 29 |
| 25/29 | 2 | | 0 | 2 | 25 | 16 | 1 | 4 | 21 | 25 | 17 | 3 | 5 | 25 | 25 | 8 | 1 | 1 | 10 | 25 | 2 | 0 | 0 | 2 | 26 | | | | | | 45 | 5 | 10 | 60 | 25 |
| 20/24 | 1 | | | 1 | 22 | 6 | 0 | 1 | 7 | 21 | 7 | 1 | 1 | 9 | 20 | 2 | 0 | 0 | 2 | 21 | 0 | | | 0 | 20 | | | | | | 16 | 1 | 2 | 19 | 21 |
| 15/19 | | | | | | 1 | 0 | 0 | 1 | 16 | 2 | 0 | 0 | 2 | 17 | 1 | 0 | | 1 | 15 | | | | | | | | | | | 4 | 0 | 0 | 4 | 16 |
| 10/14 | | | | | | 0 | | | 0 | 12 | 0 | 0 | | 0 | 10 | | | | | | | | | | | | | | | | 0 | 0 | | 0 | 11 |

A.3.10-21

## Installing Contractor's Overhead & Profit

Below are the **average** installing contractor's percentage mark-ups applied to base labor rates to arrive at typical billing rates.

**Column A:** Labor rates are based on union wages averaged for 30 major U.S. cities. Base rates including fringe benefits are listed hourly and daily. These figures are the sum of the wage rate and employer-paid fringe benefits such as vacation pay, employer-paid health and welfare costs, pension costs, plus appropriate training and industry advancement funds costs.

**Column B:** Workers' Compensation rates are the national average of state rates established for each trade.

**Column C:** Column C lists average fixed overhead figures for all trades. Included are Federal and State Unemployment costs set at 7.3%; Social Security Taxes (FICA) set at 7.65%; Builder's Risk Insurance costs set at 0.34%; and Public Liability costs set at 1.55%. All the percentages except those for Social Security Taxes vary from state to state as well as from company to company.

**Columns D and E:** Percentages in Columns D and E are based on the presumption that the installing contractor has annual billing of $500,000 and up. Overhead percentages may increase with smaller annual billing. The overhead percentages for any given contractor may vary greatly and depend on a number of factors, such as the contractor's annual volume, engineering and logistical support costs, and staff requirements. The figures for overhead and profit will also vary depending on the type of job, the job location, and the prevailing economic conditions. All factors should be examined very carefully for each job.

**Column F:** Column F lists the total of Columns B, C, D, and E.

**Column G:** Column G is Column A (hourly base labor rate) multiplied by the percentage in Column F (O&P percentage).

**Column H:** Column H is the total of Column A (hourly base labor rate) plus Column G (Total O&P).

**Column I:** Column I is Column H multiplied by eight hours.

| | | A | | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Base Rate Incl. Fringes | | Workers' Comp. Ins. | Average Fixed Overhead | Overhead | Profit | Total Overhead & Profit | | Rate with O & P | |
| Abbr. | Trade | Hourly | Daily | | | | | % | Amount | Hourly | Daily |
| Skwk | Skilled Workers Average (35 trades) | $25.95 | $207.60 | 20.2% | 16.8% | 13.0% | 10% | 60.0% | $15.55 | $41.50 | $332.00 |
| | Helpers Average (5 trades) | 19.25 | 154.00 | 21.4 | | 11.0 | | 59.2 | 11.40 | 30.65 | 245.20 |
| | Foreman Average, Inside ($.50 over trade) | 26.45 | 211.60 | 20.2 | | 13.0 | | 60.0 | 15.85 | 42.30 | 338.40 |
| | Foreman Average, Outside ($2.00 over trade) | 27.95 | 223.60 | 20.2 | | 13.0 | | 60.0 | 16.75 | 44.70 | 357.60 |
| Clab | Common Building Laborers | 19.80 | 158.40 | 21.9 | | 11.0 | | 59.7 | 11.80 | 31.60 | 252.80 |
| Asbe | Asbestos Workers | 28.55 | 228.40 | 19.7 | | 16.0 | | 62.5 | 17.85 | 46.40 | 371.20 |
| Boil | Boilermakers | 30.05 | 240.40 | 17.7 | | 16.0 | | 60.5 | 18.20 | 48.25 | 386.00 |
| Bric | Bricklayers | 25.90 | 207.20 | 19.4 | | 11.0 | | 57.2 | 14.80 | 40.70 | 325.60 |
| Brhe | Bricklayer Helpers | 20.00 | 160.00 | 19.4 | | 11.0 | | 57.2 | 11.45 | 31.45 | 251.60 |
| Carp | Carpenters | 25.20 | 201.60 | 21.9 | | 11.0 | | 59.7 | 15.05 | 40.25 | 322.00 |
| Cefi | Cement Finishers | 24.35 | 194.80 | 12.8 | | 11.0 | | 50.6 | 12.30 | 36.65 | 293.20 |
| Elec | Electricians | 29.30 | 234.40 | 8.0 | | 16.0 | | 50.8 | 14.90 | 44.20 | 353.60 |
| Elev | Elevator Constructors | 30.05 | 240.40 | 9.6 | | 16.0 | | 52.4 | 15.75 | 45.80 | 366.40 |
| Eqhv | Equipment Operators, Crane or Shovel | 26.75 | 214.00 | 12.9 | | 14.0 | | 53.7 | 14.35 | 41.10 | 328.80 |
| Eqmd | Equipment Operators, Medium Equipment | 25.70 | 205.60 | 12.9 | | 14.0 | | 53.7 | 13.80 | 39.50 | 316.00 |
| Eqlt | Equipment Operators, Light Equipment | 24.70 | 197.60 | 12.9 | | 14.0 | | 53.7 | 13.25 | 37.95 | 303.60 |
| Eqol | Equipment Operators, Oilers | 21.90 | 175.20 | 12.9 | | 14.0 | | 53.7 | 11.75 | 33.65 | 269.20 |
| Eqmm | Equipment Operators, Master Mechanics | 27.55 | 220.40 | 12.9 | | 14.0 | | 53.7 | 14.80 | 42.35 | 338.80 |
| Glaz | Glaziers | 24.90 | 199.20 | 16.0 | | 11.0 | | 53.8 | 13.40 | 38.30 | 306.40 |
| Lath | Lathers | 24.95 | 199.60 | 13.5 | | 11.0 | | 51.3 | 12.80 | 37.75 | 302.00 |
| Marb | Marble Setters | 25.65 | 205.20 | 19.4 | | 11.0 | | 57.2 | 14.65 | 40.30 | 322.40 |
| Mill | Millwrights | 26.55 | 212.40 | 13.2 | | 11.0 | | 51.0 | 13.55 | 40.10 | 320.80 |
| Mstz | Mosaic & Terrazzo Workers | 25.25 | 202.00 | 11.0 | | 11.0 | | 48.8 | 12.30 | 37.55 | 300.40 |
| Pord | Painters, Ordinary | 22.95 | 183.60 | 16.8 | | 11.0 | | 54.6 | 12.55 | 35.50 | 284.00 |
| Psst | Painters, Structural Steel | 23.95 | 191.60 | 62.5 | | 11.0 | | 100.3 | 24.00 | 47.95 | 383.60 |
| Pape | Paper Hangers | 23.30 | 186.40 | 16.8 | | 11.0 | | 54.6 | 12.70 | 36.00 | 288.00 |
| Pile | Pile Drivers | 25.35 | 202.80 | 33.6 | | 16.0 | | 76.4 | 19.35 | 44.70 | 357.60 |
| Plas | Plasterers | 24.20 | 193.60 | 17.4 | | 11.0 | | 55.2 | 13.35 | 37.55 | 300.40 |
| Plah | Plasterer Helpers | 20.15 | 161.20 | 17.4 | | 11.0 | | 55.2 | 11.10 | 31.25 | 250.00 |
| Plum | Plumbers | 30.05 | 240.40 | 10.2 | | 16.0 | | 53.0 | 15.95 | 46.00 | 368.00 |
| Rodm | Rodmen (Reinforcing) | 27.75 | 222.00 | 36.3 | | 14.0 | | 77.1 | 21.40 | 49.15 | 393.20 |
| Rofc | Roofers, Composition | 22.55 | 180.40 | 37.4 | | 11.0 | | 75.2 | 16.95 | 39.50 | 316.00 |
| Rots | Roofers, Tile & Slate | 22.60 | 180.80 | 37.4 | | 11.0 | | 75.2 | 17.00 | 39.60 | 316.80 |
| Rohe | Roofers, Helpers (Composition) | 15.95 | 127.60 | 37.4 | | 11.0 | | 75.2 | 12.00 | 27.95 | 223.60 |
| Shee | Sheet Metal Workers | 28.95 | 231.60 | 13.8 | | 16.0 | | 56.6 | 16.40 | 45.35 | 362.80 |
| Spri | Sprinkler Installers | 31.30 | 250.40 | 10.4 | | 16.0 | | 53.2 | 16.65 | 47.95 | 383.60 |
| Stpi | Steamfitters or Pipefitters | 30.30 | 242.40 | 10.2 | | 16.0 | | 53.0 | 16.05 | 46.35 | 370.80 |
| Ston | Stone Masons | 25.90 | 207.20 | 19.4 | | 11.0 | | 57.2 | 14.80 | 40.70 | 325.60 |
| Sswk | Structural Steel Workers | 27.85 | 222.80 | 46.4 | | 14.0 | | 87.2 | 24.30 | 52.15 | 417.20 |
| Tilf | Tile Layers | 25.05 | 200.40 | 11.0 | | 11.0 | | 48.8 | 12.20 | 37.25 | 298.00 |
| Tilh | Tile Layers Helpers | 20.30 | 162.40 | 11.0 | | 11.0 | | 48.8 | 9.90 | 30.20 | 241.60 |
| Trlt | Truck Drivers, Light | 20.35 | 162.80 | 17.0 | | 11.0 | | 54.8 | 11.15 | 31.50 | 252.00 |
| Trhv | Truck Drivers, Heavy | 20.70 | 165.60 | 17.0 | | 11.0 | | 54.8 | 11.35 | 32.05 | 256.40 |
| Sswl | Welders, Structural Steel | 27.85 | 222.80 | 46.4 | | 14.0 | | 87.2 | 24.30 | 52.15 | 417.20 |
| Wrck | *Wrecking | 19.80 | 158.40 | 44.8 | | 11.0 | | 82.6 | 16.35 | 36.15 | 289.20 |

*Not included in Averages.

A.3.10-22

| DIVISION | | FLORIDA | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MIAMI | | | ORLANDO | | | PANAMA CITY | | | PENSACOLA | | | ST. PETERSBURG | | | TALLAHASSEE | | |
| | | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL |
| 2 | SITE WORK | 110.3 | 72.8 | 81.5 | 125.3 | 85.9 | 95.0 | 141.6 | 83.4 | 96.9 | 138.9 | 85.9 | 98.1 | 126.2 | 85.6 | 95.0 | 125.7 | 85.2 | 94.6 |
| 031 | CONCRETE FORMWORK | 94.2 | 71.0 | 74.5 | 97.3 | 71.6 | 75.5 | 95.8 | 37.8 | 46.6 | 84.5 | 69.7 | 72.0 | 94.1 | 64.8 | 69.3 | 97.3 | 53.0 | 59.7 |
| 032 | CONCRETE REINFORCEMENT | 95.1 | 72.5 | 82.4 | 95.1 | 79.0 | 86.0 | 99.3 | 64.5 | 79.7 | 101.5 | 64.9 | 81.0 | 98.5 | 74.3 | 84.9 | 95.1 | 65.2 | 78.3 |
| 033 | CAST IN PLACE CONCRETE | 91.5 | 75.4 | 84.6 | 88.7 | 78.0 | 84.1 | 95.2 | 43.0 | 72.9 | 95.2 | 69.0 | 84.0 | 101.4 | 70.2 | 88.1 | 91.7 | 58.4 | 77.5 |
| 3 | CONCRETE | 87.4 | 74.3 | 80.8 | 86.3 | 76.7 | 81.4 | 95.0 | 46.6 | 70.5 | 93.5 | 70.1 | 81.7 | 92.6 | 70.1 | 81.2 | 87.7 | 59.2 | 73.3 |
| 4 | MASONRY | 76.9 | 70.2 | 72.8 | 77.4 | 75.6 | 76.2 | 84.9 | 37.4 | 55.4 | 82.6 | 67.6 | 73.3 | 119.2 | 66.9 | 86.7 | 83.6 | 52.6 | 64.4 |
| 5 | METALS | 98.8 | 93.5 | 96.8 | 107.9 | 95.0 | 103.0 | 97.2 | 75.1 | 88.9 | 97.1 | 89.6 | 94.3 | 101.0 | 92.4 | 97.7 | 99.2 | 88.1 | 95.0 |
| 6 | WOOD & PLASTICS | 88.6 | 72.7 | 80.6 | 94.5 | 71.1 | 82.8 | 92.9 | 38.3 | 65.6 | 80.1 | 71.1 | 75.6 | 90.8 | 65.2 | 78.0 | 94.5 | 51.6 | 73.0 |
| 7 | THERMAL & MOISTURE PROTECTION | 99.6 | 74.6 | 88.0 | 96.6 | 75.6 | 86.9 | 96.9 | 38.3 | 69.9 | 96.6 | 66.9 | 82.9 | 96.3 | 63.1 | 81.0 | 96.6 | 58.8 | 79.1 |
| 8 | DOORS & WINDOWS | 95.9 | 69.5 | 89.5 | 98.1 | 68.2 | 90.9 | 95.7 | 35.2 | 81.2 | 95.7 | 66.5 | 88.7 | 96.8 | 60.4 | 88.0 | 98.1 | 53.9 | 87.4 |
| 092 | LATH, PLASTER & GYPSUM BOARD | 101.0 | 72.5 | 82.5 | 101.6 | 70.8 | 81.7 | 99.7 | 36.9 | 59.0 | 94.5 | 70.9 | 79.2 | 98.9 | 64.8 | 76.8 | 101.6 | 50.7 | 68.6 |
| 095 | ACOUSTICAL TREATMENT & WOOD FLOORING | 102.4 | 72.5 | 83.0 | 102.4 | 70.8 | 82.0 | 96.6 | 36.9 | 58.0 | 96.6 | 70.9 | 79.9 | 98.0 | 64.8 | 76.5 | 102.4 | 50.7 | 68.9 |
| 096 | FLOORING & CARPET | 121.8 | 75.3 | 110.7 | 113.0 | 74.9 | 103.8 | 112.3 | 24.6 | 91.3 | 106.7 | 68.0 | 97.4 | 111.4 | 67.8 | 100.9 | 113.0 | 49.7 | 97.8 |
| 099 | PAINTING & WALL COVERINGS | 100.9 | 70.1 | 83.0 | 104.2 | 77.6 | 88.7 | 104.2 | 34.5 | 63.7 | 104.2 | 78.5 | 89.3 | 104.2 | 65.4 | 81.6 | 104.2 | 55.7 | 76.0 |
| 9 | FINISHES | 108.6 | 71.4 | 89.7 | 107.7 | 72.7 | 89.9 | 107.2 | 34.4 | 70.2 | 104.5 | 70.5 | 87.2 | 106.0 | 65.3 | 85.3 | 107.7 | 51.9 | 79.3 |
| 10-14 | TOTAL DIV. 10-14 | 100.0 | 81.8 | 96.1 | 100.0 | 83.9 | 96.6 | 100.0 | 65.4 | 92.6 | 100.0 | 73.3 | 94.3 | 100.0 | 76.8 | 95.1 | 100.0 | 74.0 | 94.5 |
| 15 | MECHANICAL | 100.0 | 72.9 | 88.0 | 100.0 | 70.8 | 87.1 | 100.0 | 34.6 | 71.1 | 100.0 | 68.8 | 86.2 | 100.0 | 68.7 | 86.2 | 100.0 | 54.8 | 80.0 |
| 16 | ELECTRICAL | 98.0 | 84.9 | 89.3 | 98.0 | 63.0 | 74.6 | 96.3 | 47.1 | 63.5 | 101.8 | 63.4 | 76.2 | 98.5 | 68.1 | 78.2 | 98.0 | 58.3 | 71.5 |
| 1-16 | WEIGHTED AVERAGE | 97.5 | 76.7 | 87.4 | 99.2 | 75.1 | 87.6 | 99.2 | 48.1 | 74.5 | 98.8 | 71.8 | 85.7 | 101.0 | 71.8 | 86.9 | 98.5 | 62.1 | 80.9 |

| DIVISION | | FLORIDA | | | GEORGIA | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | TAMPA | | | ALBANY | | | ATLANTA | | | AUGUSTA | | | COLUMBUS | | | MACON | | |
| | | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL |
| 2 | SITE WORK | 126.9 | 85.6 | 95.1 | 110.4 | 74.2 | 82.5 | 114.3 | 92.8 | 97.8 | 110.2 | 91.5 | 95.8 | 110.4 | 74.3 | 82.6 | 111.6 | 91.9 | 96.5 |
| 031 | CONCRETE FORMWORK | 97.3 | 64.9 | 69.8 | 96.9 | 50.8 | 57.8 | 98.0 | 70.3 | 74.5 | 94.5 | 61.8 | 66.7 | 96.9 | 50.4 | 57.4 | 95.9 | 65.9 | 70.5 |
| 032 | CONCRETE REINFORCEMENT | 95.1 | 74.3 | 83.4 | 95.1 | 76.4 | 84.6 | 98.5 | 77.5 | 86.7 | 104.0 | 69.1 | 84.4 | 95.1 | 76.4 | 84.6 | 97.4 | 76.7 | 85.8 |
| 033 | CAST IN PLACE CONCRETE | 101.7 | 70.2 | 88.2 | 95.5 | 48.9 | 75.6 | 101.1 | 71.2 | 88.3 | 95.6 | 57.9 | 79.5 | 95.5 | 49.5 | 75.8 | 95.5 | 53.3 | 77.5 |
| 3 | CONCRETE | 92.4 | 70.2 | 81.2 | 89.4 | 57.0 | 73.0 | 94.0 | 72.1 | 82.9 | 90.5 | 62.2 | 76.2 | 89.4 | 57.0 | 73.0 | 89.7 | 65.1 | 77.3 |
| 4 | MASONRY | 82.8 | 66.9 | 72.9 | 83.4 | 38.9 | 55.7 | 92.1 | 63.6 | 74.4 | 92.2 | 49.1 | 65.4 | 83.4 | 39.3 | 56.0 | 98.6 | 46.7 | 66.4 |
| 5 | METALS | 102.2 | 92.4 | 98.5 | 96.8 | 89.0 | 93.9 | 93.7 | 74.5 | 86.4 | 92.4 | 69.4 | 83.7 | 96.7 | 89.3 | 93.9 | 91.7 | 90.1 | 91.1 |
| 6 | WOOD & PLASTICS | 94.5 | 65.2 | 79.8 | 93.7 | 51.6 | 72.6 | 99.7 | 72.2 | 86.0 | 95.9 | 64.6 | 80.3 | 93.7 | 51.3 | 72.5 | 97.4 | 69.9 | 83.6 |
| 7 | THERMAL & MOISTURE PROTECTION | 96.6 | 64.3 | 81.7 | 96.4 | 55.7 | 77.6 | 94.2 | 70.0 | 83.0 | 93.6 | 59.5 | 77.9 | 96.1 | 55.7 | 77.5 | 95.1 | 62.9 | 80.2 |
| 8 | DOORS & WINDOWS | 98.1 | 60.4 | 89.0 | 95.9 | 53.7 | 85.7 | 94.2 | 67.9 | 87.9 | 90.6 | 59.3 | 83.1 | 95.9 | 53.8 | 85.7 | 94.2 | 64.8 | 87.1 |
| 092 | LATH, PLASTER & GYPSUM BOARD | 101.6 | 64.8 | 77.7 | 101.6 | 50.7 | 68.6 | 112.5 | 72.0 | 86.2 | 111.3 | 64.1 | 80.7 | 101.6 | 50.4 | 68.4 | 108.3 | 69.5 | 83.2 |
| 095 | ACOUSTICAL TREATMENT & WOOD FLOORING | 102.4 | 64.8 | 78.1 | 102.4 | 50.7 | 69.0 | 108.7 | 72.0 | 84.9 | 108.7 | 64.1 | 79.8 | 102.4 | 50.4 | 68.7 | 95.9 | 69.5 | 78.8 |
| 096 | FLOORING & CARPET | 113.0 | 67.8 | 102.1 | 113.0 | 40.4 | 95.6 | 87.8 | 75.0 | 84.8 | 86.7 | 51.5 | 78.2 | 113.0 | 41.0 | 95.7 | 87.8 | 47.5 | 78.2 |
| 099 | PAINTING & WALL COVERINGS | 104.2 | 65.4 | 81.6 | 100.9 | 50.4 | 71.5 | 99.0 | 72.1 | 83.4 | 99.0 | 47.9 | 69.3 | 100.9 | 48.3 | 70.3 | 102.4 | 59.0 | 77.2 |
| 9 | FINISHES | 107.7 | 65.3 | 86.1 | 105.8 | 48.1 | 76.4 | 95.1 | 71.5 | 83.1 | 94.4 | 58.6 | 76.1 | 105.7 | 47.8 | 76.2 | 91.5 | 62.0 | 76.5 |
| 10-14 | TOTAL DIV. 10-14 | 100.0 | 76.8 | 95.1 | 100.0 | 69.5 | 93.5 | 100.0 | 75.4 | 94.8 | 100.0 | 71.0 | 93.8 | 100.0 | 69.4 | 93.5 | 100.0 | 73.6 | 94.4 |
| 15 | MECHANICAL | 100.0 | 68.7 | 86.2 | 100.0 | 56.8 | 80.9 | 100.1 | 71.7 | 87.5 | 100.1 | 54.0 | 79.7 | 100.0 | 46.2 | 76.2 | 100.0 | 52.1 | 78.8 |
| 16 | ELECTRICAL | 97.5 | 68.1 | 77.9 | 93.3 | 68.1 | 76.5 | 93.4 | 82.3 | 86.0 | 96.9 | 61.3 | 73.2 | 93.3 | 49.4 | 64.0 | 91.4 | 63.3 | 72.7 |
| 1-16 | WEIGHTED AVERAGE | 99.5 | 71.8 | 86.1 | 97.1 | 60.8 | 79.5 | 96.5 | 75.0 | 86.1 | 95.5 | 62.5 | 79.5 | 97.1 | 55.7 | 77.1 | 95.4 | 65.4 | 80.9 |

| DIVISION | | GEORGIA | | | | | | HAWAII | | | IDAHO | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SAVANNAH | | | VALDOSTA | | | HONOLULU | | | BOISE | | | LEWISTON | | | POCATELLO | | |
| | | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL | MAT. | INST. | TOTAL |
| 2 | SITE WORK | 110.6 | 76.1 | 84.0 | 122.0 | 74.5 | 85.5 | 115.0 | 112.0 | 112.7 | 86.4 | 99.3 | 96.3 | 90.4 | 92.7 | 92.2 | 89.1 | 99.3 | 96.9 |
| 031 | CONCRETE FORMWORK | 97.0 | 60.5 | 66.0 | 80.8 | 51.9 | 56.3 | 102.1 | 158.7 | 150.1 | 97.4 | 89.3 | 90.5 | 106.3 | 87.1 | 90.0 | 97.4 | 89.3 | 90.5 |
| 032 | CONCRETE REINFORCEMENT | 100.7 | 69.5 | 83.2 | 100.8 | 50.3 | 72.5 | 109.9 | 125.0 | 118.4 | 96.0 | 78.4 | 86.1 | 108.6 | 96.1 | 101.6 | 96.3 | 78.5 | 86.3 |
| 033 | CAST IN PLACE CONCRETE | 91.5 | 56.6 | 76.6 | 93.0 | 57.4 | 77.8 | 170.2 | 127.7 | 152.0 | 98.6 | 93.8 | 96.6 | 107.8 | 93.9 | 101.8 | 99.6 | 93.8 | 97.1 |
| 3 | CONCRETE | 88.3 | 62.5 | 75.3 | 92.8 | 55.5 | 74.0 | 153.0 | 139.4 | 146.1 | 103.2 | 88.7 | 95.9 | 115.5 | 91.0 | 103.1 | 103.7 | 88.6 | 96.1 |
| 4 | MASONRY | 86.9 | 57.6 | 68.7 | 89.8 | 50.6 | 65.4 | 131.3 | 134.3 | 133.2 | 131.8 | 81.0 | 100.2 | 128.8 | 96.6 | 108.8 | 136.3 | 82.7 | 103.0 |
| 5 | METALS | 97.1 | 87.6 | 93.5 | 96.5 | 80.7 | 90.6 | 117.4 | 107.6 | 113.7 | 112.9 | 82.2 | 101.3 | 96.2 | 90.7 | 94.1 | 112.5 | 82.2 | 101.1 |
| 6 | WOOD & PLASTICS | 93.8 | 60.9 | 77.3 | 76.0 | 50.3 | 63.1 | 100.6 | 165.6 | 133.1 | 95.1 | 88.5 | 91.8 | 98.7 | 83.6 | 91.2 | 95.1 | 88.5 | 91.8 |
| 7 | THERMAL & MOISTURE PROTECTION | 96.4 | 59.2 | 79.3 | 96.1 | 60.0 | 79.5 | 109.5 | 133.7 | 120.6 | 97.9 | 84.0 | 91.5 | 167.6 | 89.8 | 131.7 | 98.0 | 83.8 | 91.5 |
| 8 | DOORS & WINDOWS | 95.9 | 56.7 | 86.4 | 91.4 | 46.3 | 80.5 | 110.6 | 146.5 | 119.2 | 94.9 | 81.7 | 91.7 | 116.3 | 85.0 | 108.7 | 94.9 | 78.5 | 91.0 |
| 092 | LATH, PLASTER & GYPSUM BOARD | 101.6 | 60.4 | 74.9 | 93.7 | 49.4 | 65.0 | 95.7 | 167.7 | 142.3 | 89.0 | 87.9 | 88.3 | 135.3 | 83.0 | 101.4 | 89.0 | 87.9 | 88.3 |
| 095 | ACOUSTICAL TREATMENT & WOOD FLOORING | 102.4 | 60.4 | 75.2 | 98.0 | 49.4 | 66.5 | 132.8 | 167.7 | 155.4 | 96.2 | 87.9 | 90.8 | 144.9 | 83.0 | 104.8 | 96.2 | 87.9 | 90.8 |
| 096 | FLOORING & CARPET | 113.0 | 60.7 | 100.4 | 105.1 | 48.5 | 91.5 | 127.8 | 128.3 | 127.9 | 97.5 | 74.8 | 92.1 | 135.1 | 97.9 | 126.2 | 97.5 | 74.8 | 92.1 |
| 099 | PAINTING & WALL COVERINGS | 100.9 | 59.9 | 77.0 | 100.9 | 43.7 | 67.6 | 123.8 | 148.0 | 137.9 | 109.4 | 67.9 | 85.2 | 134.4 | 91.3 | 109.3 | 109.4 | 78.2 | 91.3 |
| 9 | FINISHES | 105.8 | 60.5 | 82.8 | 101.9 | 50.0 | 75.5 | 124.5 | 153.9 | 139.5 | 93.2 | 84.6 | 88.8 | 156.4 | 89.0 | 122.1 | 93.2 | 85.8 | 89.4 |
| 10-14 | TOTAL DIV. 10-14 | 100.0 | 71.7 | 94.0 | 100.0 | 70.1 | 93.7 | 100.0 | 129.2 | 106.2 | 100.0 | 86.1 | 97.0 | 100.0 | 100.6 | 100.1 | 100.0 | 86.1 | 97.0 |
| 15 | MECHANICAL | 100.0 | 55.8 | 80.5 | 100.0 | 48.7 | 77.3 | 100.1 | 119.4 | 108.6 | 99.8 | 85.6 | 93.5 | 100.6 | 94.1 | 97.7 | 99.8 | 85.6 | 93.5 |
| 16 | ELECTRICAL | 93.3 | 65.4 | 74.7 | 90.2 | 40.8 | 57.2 | 109.7 | 128.8 | 122.5 | 85.2 | 78.7 | 80.9 | 87.5 | 92.2 | 90.6 | 85.7 | 79.4 | 81.5 |
| 1-16 | WEIGHTED AVERAGE | 97.2 | 64.6 | 81.4 | 96.8 | 55.0 | 76.6 | 115.9 | 129.5 | 122.5 | 101.0 | 85.2 | 93.4 | 111.9 | 92.1 | 102.3 | 101.3 | 85.5 | 93.7 |

A.3.10-23

# ECO NUMBER 11

## CONTRACT WITH A LEAK DETECTION SERVICE OR PURCHASE LEAK LOCATING EQUIPMENT FOR USE WHEN A MAJOR HTW LEAK OCCURS

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-11
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-11 PURCHASE LEAK DETECTION EQUIPMENT
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 05-06-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 55500. | | |
| B. SIOH | $ 0. | | |
| C. DESIGN COST | $ 0. | | |
| D. TOTAL COST (1A+1B+1C) | $ 55500. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 55500. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 1. | 15.08 | $ 21. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 76. | $ 102. | 14.88 | $ 1511. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 76. | $ 103. | | $ 1532. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 5658.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 84191.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 84191.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 5761.

5. SIMPLE PAYBACK PERIOD (1G/4) 9.63 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 85723.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.54
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

WITH ECO's 9A & 12A

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-11X
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-11 PURCHASE LEAK DETECTION EQUIPMENT
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 05-06-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT
A. CONSTRUCTION COST $ 55500.
B. SIOH $ 0.
C. DESIGN COST $ 0.
D. TOTAL COST (1A+1B+1C) $ 55500.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 55500.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 1. | 15.08 | $ 21. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 66. | $ 88. | 14.88 | $ 1306. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 66. | $ 89. | | $ 1327. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 5658.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 84191.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 84191.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 5747.

5. SIMPLE PAYBACK PERIOD (1G/4) 9.66 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 85518.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.54
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

WITH ECO'S 9A, 12A & 12B

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-11Y
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-11 PURCHASE LEAK DETECTION EQUIPMENT
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 05-06-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT
A. CONSTRUCTION COST $ 55500.
B. SIOH $ 0.
C. DESIGN COST $ 0.
D. TOTAL COST (1A+1B+1C) $ 55500.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 55500.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 1. | 15.08 | $ 21. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 58. | $ 78. | 14.88 | $ 1156. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 58. | $ 79. | | $ 1177. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 5658.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 84191.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 84191.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 5737.

5. SIMPLE PAYBACK PERIOD (1G/4) 9.67 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 85368.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.54
(IF < 1 PROJECT DOES NOT QUALIFY)
**** Project does not qualify for ECIP funding; 4,5,6 for information only.

RS&H

| | | | |
|---|---|---|---|
| SUBJECT | Fort Stewart Purchase Leak Correlator | AEP NO | 694 1331 002 |
| DESIGNER | W. Todd | SHEET | 1 OF |
| CHECKER | | DATE | 2-7-96 |
| | | DATE | Rev. 4-12-96 |

# ECO-11 PURCHASE LEAK CORRELATOR

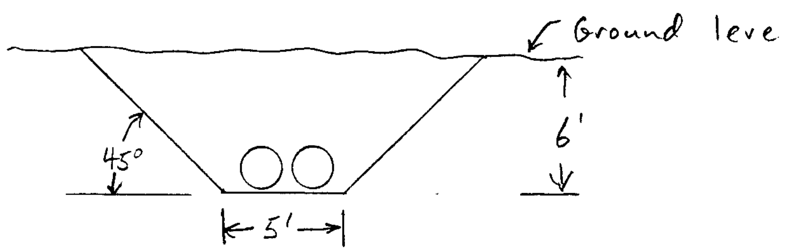
## W/o Leak Correlator

Assume 3 dig and cut operations are required to find a typical HTW leak.

Average distance between valve pits:

$$\frac{9100 \text{ lf} + 4600 \text{ lf} + 6700 \text{ lf} + 17400 \text{ lf} + 8750 \text{ lf}}{95 \text{ Valve Pits}} = 490 \text{ LF/pit}$$

Area of excavation: Assume 1 dig is 20' long and:




$$6' \times 11' \times 20' = 1320 \text{ Ft}^3 \div 27 \frac{CF}{CY} = 48.9 \Rightarrow \text{say } 50 \frac{CY}{DIG} \times 3 \text{ DIGS} = 150 \text{ CY}$$

Using a combination of backhoe and hand excavation and assuming 60 % (150 × 0.6 = 90 cy) will be done by backhoe and 40% (150 × 0.4 = 60 CY) will be done by hand. The time required to find the leak is:

Backhoe : 90 CY × 0.080 hr/cy ÷ 24 hr/day ≈ 0.3 day (96MM p 28)
By Hand : 60 CY × 1.5 hr/cy ÷ 24 hr/day ÷ 4 men ≈ 0.94 day (96mm p 28)

HTW Lost : (See graph of 1995 Make-up water use)

Average loss during leak = 25000 GPD
Average 1995 Make-up use = 10000 GPD

(25000 GPD − 10000 GPD) × 1.24 Day/leak ≈ 18,560 Gal/leak

**RS&H**

SUBJECT Fort Stewart
Purchase Leak Correlator
DESIGNER W. Todd
CHECKER

AEP NO 694 1331 002
SHEET 2 OF
DATE 2-7-96
DATE Rev. 4-12-96

ECO-11

## With Leak Correlator

Assume only have to dig 20 linear feet. Vendor indicated leak could be located within inches (see call confermation) on the first dig.

Area of excavation:

$6' \times 11' \times 20' = 1320$ CF $\div 27$ CF/CY $= 49 \Rightarrow 50$ CY

Assume 60 % will be done by backhoe; $50 \times 0.6 = 30$ cy
Assume 40 % will be done by hand; $50 \times 0.4 = 20$ cy

Time Required:
By hand: 20 CY $\times$ 1.5 $\frac{hr}{CY}$ $\div$ 4 men $\div$ 24 hr/day = 0.31 day (96MM p28)
W/ backhoe: 30 CY $\times$ 0.080 hr/cy $\div$ 24 hr/day = 0.1 day (96MM p 28)

Assume 4 hours for leak correlator test

0.31 day + 0.1 day + 0.17 day = 0.58 days/leak

HTW Lost:

(25000 GPD - 10000 GPD) $\times$ 0. day = 8,650 Gal/leak

RS&H

SUBJECT FORT STEWART
PURCHASE LEAK CORRELATOR
DESIGNER W. TODD
CHECKER

AEP NO 694 1331 002
SHEET 3 OF
DATE 2-7-96
DATE Rev. 4-12-96

ECO - 11

W/o Leak Correlator :

O&M Costs = (From estimate EST-11B.WB2 = \$9133 /YR

HTW Losses = $18,560 \frac{GAL}{Leak} \times 2 \frac{leaks}{YR} = 37,120 \frac{GAL}{YR}$

Heating Fuel Use = 141.2 mBtu/YR

Electricity Use = $54 \frac{kwh}{YR} \times 0.003413 \frac{mBtu}{kwh} = 0.2 \frac{mBtu}{YR}$

Water Cost = $37,120 \frac{Gal}{YR} \times \$0.5562/1000\ GAL = \$21/YR$

With Leak Correlator :

O&M Costs = (from estimate EST-11A.WB2 = \$3486/YR

HTW Losses = $8650 \frac{GAL}{Leak} \times 2 \frac{leaks}{YR} = 17300\ GAL/YR$

Heating Fuel Use = 65.8 mBtu/YR

Electricity Use = $25 \frac{kwh}{YR} \times 0.003413 \frac{mBtu}{kwh} = 0.1 \frac{mBtu}{YR}$

Water Cost = $17,300 \frac{GAL}{YR} \times \$0.5562/1000\ GAL = \$10/YR$

ANNUAL SAVINGS

HEATING FUELS = 141.2 - 65.8 = 75.8 mBtu/YR
ELECTRICITY = 0.2 - 0.1 = 0.1 mBtu/YR
WATER = \$21 - \$10 = \$11 /YR
O&M = \$9133 - \$3486 = \$5647 /YR

# CONSTRUCTION COST ESTIMATE

Project: Repair HTW Piping Leaks
Location: Fort Stewart, GA
Basis: Schematic Design
ECO Number: 11

RS&H No.: 694-1331-002
Date: 04/12/96
Estimator: W.T.Todd
Filename: EST-11A.WB2

| ITEM DESCRIPTION | QUANTITY No. | QUANTITY Unit | MATERIAL/EQUIP $/Unit | MATERIAL/EQUIP Total | LABOR $/Unit | LABOR Total | TOTAL COST | SOURCE Material | SOURCE Labor |
|---|---|---|---|---|---|---|---|---|---|
| Shut off HTW zone | 4 | MH | 0 | 0 | 30.30 | 121 | 121 | | MMp475 |
| Perform leak locator test | 4 | MH | 0 | 0 | 30.30 | 121 | 121 | | MMp475 |
| Excavation, backhoe to 6' | 30 | CY | 1.43 | 43 | 1.82 | 55 | 98 | MMp28 | MMp28 |
| Excavation, by hand to 6' | 20 | CY | 0 | 0 | 29.65 | 593 | 593 | MMp28 | MMp28 |
| Remove conduit, torch | 6 | LF | 1.06 | 6 | 4.95 | 30 | 36 | MMp22 | MMp22 |
| Remove pipe insulation | 2 | LF | 0 | 0 | 4.84 | 10 | 10 | | MMp236 |
| Valve off and drain pipe | 0.50 | MH | 0 | 0 | 30.30 | 15 | 15 | | MMp475 |
| Repair HTW leak - Weld | 1 | Ea | 1.95 | 2 | 16.05 | 16 | 18 | MMp144 | MMp144 |
| Open valves - fill pipe | 0.50 | Ea | 0 | 0 | 30.30 | 15 | 15 | | MMp475 |
| Replace pipe insulation | 2 | LF | 0 | 0 | 4.84 | 10 | 10 | | MMp236 |
| Weld conduit, 24" Sch 40 | 1 | Ea | 35 | 35 | 289 | 289 | 324 | MMp144 | MMp144 |
| Backfill trench, by hand | 20 | CY | | 0 | 12.85 | 257 | 257 | MMp28 | MMp28 |
| Compact backfill, by hand | 20 | CY | | 0 | 4.66 | 93 | 93 | MMp28 | MMp28 |
| Backfill trench, dozer | 30 | CY | 0.95 | 29 | 0.32 | 10 | 39 | MMp28 | MMp28 |
| Compact backfill, dozer | 30 | CY | 1.37 | 41 | 0.41 | 12 | 53 | MMp28 | MMp28 |
| | | | | | | | | | |
| Total Cost per Leak | | | | 156 | | 1647 | 1,803 | | |
| | | | | | | | | | |
| Total Cost for All Leaks | 2 | Ea | 156 | 312 | 1647 | 3294 | 3,606 | | |
| Subtotal Bare Costs | | | | 312 | | 3294 | $3,606 | | |
| Retrofit Cost Factors | | | 0% | 0 | 0% | 0 | 0 | MMp6 | MMp6 |
| Subtotal | | | | 312 | | 3294 | 3,606 | | |
| City Cost Index (Sav. GA) | | | 0% | 0 | -44% | -1456 | (1,456) | MMp533 | MMp533 |
| Subtotal | | | | 312 | | 1838 | 2,150 | | |
| OH & Profit Markups | | | 10% | 31 | 53% | 974 | 1,005 | MMp7 | MMp475 |
| Subtotal | | | | 343 | | 2812 | 3,155 | | |
| Sales Taxes | | | 4.0% | 14 | | NA | 14 | MMp476 | |
| Subtotal | | | | 357 | | 2812 | 3,169 | | |
| Contingency | | | 10% | 36 | 10% | 281 | 317 | MEp6 | MEp6 |
| Total Construction Cost | | | | 393 | | 3093 | 3,486 | | |
| Design Fee | | | | NA | 0.0% | 0 | 0 | | |
| SIOH | | | | NA | 0.0% | 0 | 0 | | |
| Total Project Cost | | | | 393 | | 3093 | $3,486 | | |

LEGEND:
- MEp### 1996 Means Electrical Cost Data, page ###.
- MMp### 1996 Means Mechanical Cost Data, page ###.

# CONSTRUCTION COST ESTIMATE

Project: Repair HTW Piping Leaks
Location: Fort Stewart, GA
Basis: Schematic Design
ECO Number: 11

RS&H No.: 694-1331-002
Date: 04/12/96
Estimator: W.T.Todd
Filename: EST-11B.WB2

| | QUANTITY | | MATERIAL/EQUIP | | LABOR | | TOTAL | SOURCE | |
|---|---|---|---|---|---|---|---|---|---|
| ITEM DESCRIPTION | No. | Unit | $/Unit | Total | $/Unit | Total | COST | Material | Labor |
| Shut off HTW zone | 4 | MH | 0 | 0 | 30.30 | 121 | 121 | | MMp475 |
| | | | | | | | | | |
| Excavation, backhoe to 6' | 90 | CY | 1.43 | 129 | 1.82 | 164 | 293 | MMp28 | MMp28 |
| Excavation, by hand to 6' | 60 | CY | 0 | 0 | 29.65 | 1779 | 1,779 | MMp28 | MMp28 |
| Remove conduit, torch | 18 | LF | 1.06 | 19 | 4.95 | 89 | 108 | MMp22 | MMp22 |
| Remove pipe insulation | 6 | LF | 0 | 0 | 4.84 | 29 | 29 | | MMp236 |
| Valve off and drain pipe | 0.50 | MH | 0 | 0 | 30.30 | 15 | 15 | | MMp475 |
| Repair HTW leak - Weld | 1 | Ea | 1.95 | 2 | 16.05 | 16 | 18 | MMp144 | MMp144 |
| Open valves - fill pipe | 0.50 | Ea | 0 | 0 | 30.30 | 15 | 15 | | MMp475 |
| Replace pipe insulation | 6 | LF | 0 | 0 | 4.84 | 29 | 29 | | MMp236 |
| Weld conduit, 24" Sch 40 | 3 | Ea | 35 | 105 | 289 | 867 | 972 | MMp144 | MMp144 |
| Backfill trench, by hand | 60 | CY | | 0 | 12.85 | 771 | 771 | MMp28 | MMp28 |
| Compact backfill, by hand | 60 | CY | | 0 | 4.66 | 280 | 280 | MMp28 | MMp28 |
| Backfill trench, dozer | 90 | CY | 0.95 | 86 | 0.32 | 29 | 115 | MMp28 | MMp28 |
| Compact backfill, dozer | 90 | CY | 1.37 | 123 | 0.41 | 37 | 160 | MMp28 | MMp28 |
| | | | | | | | | | |
| Total Cost per Leak | | | | 464 | | 4241 | 4,705 | | |
| | | | | | | | | | |
| Total Cost for All Leaks | 2 | Ea | 464 | 928 | 4241 | 8482 | 9,410 | | |
| Subtotal Bare Costs | | | | 928 | | 8482 | $9,410 | | |
| Retrofit Cost Factors | | | 0% | 0 | 0% | 0 | 0 | MMp6 | MMp6 |
| Subtotal | | | | 928 | | 8482 | 9,410 | | |
| City Cost Index (Sav. GA) | | | 0% | 0 | -44% | -3749 | (3,749) | MMp533 | MMp533 |
| Subtotal | | | | 928 | | 4733 | 5,661 | | |
| OH & Profit Markups | | | 10% | 93 | 53% | 2508 | 2,601 | MMp7 | MMp475 |
| Subtotal | | | | 1021 | | 7241 | 8,262 | | |
| Sales Taxes | | | 4.0% | 41 | | NA | 41 | MMp476 | |
| Subtotal | | | | 1062 | | 7241 | 8,303 | | |
| Contingency | | | 10% | 106 | 10% | 724 | 830 | MEp6 | MEp6 |
| Total Construction Cost | | | | 1168 | | 7965 | 9,133 | | |
| Design Fee | | | | NA | 0.0% | 0 | 0 | | |
| SIOH | | | | NA | 0.0% | 0 | 0 | | |
| Total Project Cost | | | | 1168 | | 7965 | $9,133 | | |

LEGEND:
MEp### 1996 Means Electrical Cost Data, page ###.
MMp### 1996 Means Mechanical Cost Data, page ###.

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. | |
| AEP Number: | 694-1331-002 | Designer: | W. T. Todd |
| Project: | Without Leak Locating Equipment | Date: | 05/06/96 |
| ECO Number: | 11 | | |

Assumptions:

| | | |
|---|---|---|
| 1. HTW temperature | 380 | °F |
| 2. Make-up water temperature | 70 | °F |
| 3. Boiler efficiency | 68% | |
| 4. Pump head (from record drawings) | 300 | Ft H20 |
| 5. Pump efficiency (from record drawings) | 72% | |
| 6. Motor efficiency | 90% | |
| 7. Average heating fuel cost | $1.34 | /MBtu |
| 8. Electricity cost | $0.0469 | /kWh |
| 9. Water cost | $0.5562 | /kGallons |

Energy Loss Calculations:

Energy Use = flow rate x specific heat x temperature difference

37120 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 96.0 MBtu/Yr

Heating Fuel Use = 96.0 MBtu/yr / 0.68 = 141.2 MBtu/Yr

Heating Fuel Cost = 141.2 MBtu/yr x $1.34 /MBtu = $189 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$\text{BHP} = \frac{0.07 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.01 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency ) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.01 BHP / 0.90 x 0.746 kW/HP = 0.01 kW

Electricity Use = 0.01 kW x 8760 Hr/Yr = 54 kWh/Yr

Electricity Cost = 54 kWh/Yr x $0.0469 /kWh = $3 /Year

Water Cost:

37120 Gal/Yr x $0.5562 /kGal = $21 /Year

Total Utility Cost Savings:

| | | |
|---|---|---|
| Heating Fuel Cost | $189 | /Year |
| Pumping (Elec) Cost | $3 | /Year |
| Water Cost | $21 | /Year |
| Total Savings | $213 | /Year |

| | | |
|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. |
| AEP Number: | 694-1331-002 | Designer: W. T. Todd |
| Project: | With Leak Locating Equipment | Date: 05/06/96 |
| ECO Number: | 11 | |

Assumptions:

| | | |
|---|---|---|
| 1. HTW temperature | 380 | °F |
| 2. Make-up water temperature | 70 | °F |
| 3. Boiler efficiency | 68% | |
| 4. Pump head (from record drawings) | 300 | Ft H20 |
| 5. Pump efficiency (from record drawings) | 72% | |
| 6. Motor efficiency | 90% | |
| 7. Average heating fuel cost | $1.34 | /MBtu |
| 8. Electricity cost | $0.0469 | /kWh |
| 9. Water cost | $0.5562 | /kGallons |

Energy Loss Calculations:

Energy Use = flow rate x specific heat x temperature difference

17300 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 44.8 MBtu/Yr

Heating Fuel Use = 44.8 MBtu/yr / 0.68 = 65.8 MBtu/Yr

Heating Fuel Cost = 65.8 MBtu/yr x $1.34 /MBtu = $88 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$\text{BHP} = \frac{0.03 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.003 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency ) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.003 BHP / 0.90 x 0.746 kW/HP = 0.003 kW

Electricity Use = 0.003 kW x 8760 Hr/Yr = 25 kWh/Yr

Electricity Cost = 25 kWh/Yr x $0.0469 /kWh = $1 /Year

Water Cost:

17300 Gal/Yr x $0.5562 /kGal = $10 /Year

Total Utility Cost Savings:

| | | |
|---|---|---|
| Heating Fuel Cost | $88 | /Year |
| Pumping (Elec) Cost | $1 | /Year |
| Water Cost | $10 | /Year |
| Total Savings | $99 | /Year |

Fort Stewart – Central Energy Plant
Filename: FS-VPDIS.WQ1
12/15/95

Approximate Distance Between Valve Pits (1)

| ZONE 1 | | ZONE 2N | | ZONE 2S | | ZONE 3 | | SEP ZONE | | |
|---|---|---|---|---|---|---|---|---|---|---|
| PIT# | LN.FT. | PIT# | LN.FT. | PIT# | LN.FT. | PIT# | LN.FT. | PIT# | LN.FT. | |
| CP–B1 | 200 | CP–V1 | 150 | V1–B1 | 700 | CP–? | 700 | C1–V1 | 1500 | (2) |
| B1–V4 | 1000 | V1–V2 | 200 | B1–V1 | 1500 | ?–1 | 800 | V1–V2 | 100 | (2) |
| V1–V2 | 600 | V2–V3 | 350 | V1–B2 | 300 | ?–2 | 400 | V2–V3 | 1700 | (2) |
| V2–V3 | 200 | V3–V4 | 650 | B2–B3 | 550 | 2–2A | 400 | V3–V4 | 450 | (2) |
| V3–V4 | 350 | V4–V5 | 600 | B3–V1 | 250 | 2A–3 | 500 | V4–V5 | 600 | (2) |
| V4–V5 | 300 | V5–V6 | 800 | V1–V2 | 250 | 3–3A | 400 | V5–V6 | 500 | (2) |
| V5–V6 | 550 | V6–V7 | 800 | V1–V3 | 350 | 3A–6 | 550 | V6–SP | 100 | (2) |
| V6–V7 | 400 | V2–V8 | 750 | V3–V4 | 250 | 4–5 | 900 | SP–V7 | 200 | |
| V7–V8 | 600 | V8–V9 | 300 | V3–V6 | 300 | 5–6 | 650 | V7–V8 | 150 | |
| V8–V9 | 350 | | | V4–V5 | 200 | 6–7 | 850 | V8–V9 | 550 | |
| V9–V10 | 350 | | | V3–V7 | 650 | 7–8 | 950 | V9–V10 | 650 | |
| V10–V11 | 250 | | | V7–V8 | 250 | 8–9 | 1000 | V10–V11 | 800 | |
| V11–V12 | 500 | | | V8–V9 | 500 | 9–10 | 1000 | V11–V12 | 650 | |
| V12–V13 | 1000 | | | V9–V10 | 200 | 10–11 | 900 | V12–V13 | 800 | |
| V13–V14 | 350 | | | V9–V11 | 450 | 11–12 | 500 | | | |
| V14–V15 | 400 | | | | | 12–13 | 950 | | | |
| V15–V16 | 400 | | | | | 13–13A | 750 | | | |
| V16–V17 | 500 | | | | | 12–14 | 950 | | | |
| V17–V18 | 800 | | | | | 14–15 | 200 | | | |
| | | | | | | 15–16 | 250 | | | |
| | | | | | | 16–16A | 300 | | | |
| | | | | | | 16A–17 | 200 | | | |
| | | | | | | 17–18 | 200 | | | |
| | | | | | | 18–19 | 100 | | | |
| | | | | | | 19–20 | 150 | | | |
| | | | | | | 20–22 | 200 | | | |
| | | | | | | 21–22 | 100 | | | |
| | | | | | | 22–23 | 350 | | | |
| | | | | | | 15–24C | 350 | | | |
| | | | | | | 24C–24B | 200 | | | |
| | | | | | | 24B–24 | 200 | | | |
| | | | | | | 24–24A | 200 | | | |
| | | | | | | 24A–25 | 150 | | | |
| | | | | | | 24A–25A | 300 | | | |
| | | | | | | 25A–26 | 100 | | | |
| | | | | | | 26–26A | 200 | | | |
| | | | | | | 26A–27 | 250 | | | |
| | | | | | | 27–28 | 250 | | | |

| | ZONE 1 | ZONE 2N | ZONE 2S | ZONE 3 | SEP ZONE | |
|---|---|---|---|---|---|---|
| TOTAL LN.FT. | 9100 | 4600 | 6700 | 17400 | 8750 | |
| MILES | 1.7 | 0.9 | 1.3 | 3.3 | 1.7 | 8.8 |
| MAX LNFT/VP | 1000 | 800 | 1500 | 1000 | 1700 | |
| AVG LNFT/VP | 479 | 511 | 447 | 458 | 625 | |
| MIN LNFT/VP | 200 | 150 | 200 | 100 | 100 | |
| NO. OF PITS (1) | 19 | 9 | 15 | 38 | 14 | 95 |

(1) There are other valve boxes and drain pits that are not shown on our HTW system map.

(2) These pipes carry steam.

# CONSTRUCTION COST ESTIMATE

Project: Purchase Leak Detection Equipment
Location: Fort Stewart, GA
Basis: Schematic Design
ECO No.: 11

RS&H No.: 694-1331-002
Date: 02/14/96
Estimator: W.T.Todd
Filename: EST-11.WQ1

| ITEM DESCRIPTION | QUANTITY No. | QUANTITY Unit | MATERIAL/EQUIP $/Unit | MATERIAL/EQUIP Total | LABOR $/Unit | LABOR Total | TOTAL COST | SOURCE Material | SOURCE Labor |
|---|---|---|---|---|---|---|---|---|---|
| Leak Correlator w/ 2 | | | | | | | | | |
| sensors/transmittors | 1 | Ea | 51000 | 51000 | | 0 | 51,000 | Vendor | |
| 4.5 day on-site class | | | | | | | | | |
| room and field work | | | | | | | | | |
| training session | 1 | Ea | | 0 | 4500 | 4500 | 4,500 | | Vendor |
| Subtotal Bare Costs | | | | 51000 | | 4500 | $55,500 | | |
| Retrofit Cost Factors | | | 0% | 0 | 0% | 0 | 0 | MMp6 | MMp6 |
| Subtotal | | | | 51000 | | 4500 | 55,500 | | |
| City Cost Index (Sav. GA) | | | 0% | 0 | 0% | 0 | 0 | MMp533 | MMp533 |
| Subtotal | | | | 51000 | | 4500 | 55,500 | | |
| OH & Profit Markups | | | 0% | 0 | 0% | 0 | 0 | MMp7 | MMp475 |
| Subtotal | | | | 51000 | | 4500 | 55,500 | | |
| Sales Taxes | | | 0.0% | 0 | | NA | 0 | MMp476 | |
| Total Construction Cost | | | | 51000 | | 4500 | 55,500 | | |
| Design Fee | | | | NA | 0.0% | 0 | 0 | | |
| SIOH | | | | NA | 0.0% | 0 | 0 | | |
| Subtotal | | | | 51000 | | 4500 | 55,500 | | |
| Contingency | | | 0% | 0 | 0% | 0 | 0 | MEp6 | MEp6 |
| Total Project Cost | | | | 51000 | | 4500 | $55,500 | | |

LEGEND:
Vendor  Price quote from telephone conversation with vendor.

**RS&H**®

**Telephone Call Confirmation**

Project Number 694 1331 002

Local ______ L.D. 800·327·2871 Placed B. Todd Rec'd ______ Date 2-6-96

Conversed with Tom McGee Of Fluid Conservation Systems Cincinnati, OH

Regarding Purchase of leak locating equipment

The leak locator is called a Correlator, and includes two sensors with transmitters. The model C-2000 is about 10 years old. The new models are:

| | | |
|---|---|---|
| MicroCorr Cub (made in UK) | $35,000 | low end |
| Tri Corr - 2001 (made in USA) | $51,000 | high end |

Correlator has receiver; input pipe diameter, type and distance between valve contact locations; usually locates the leak within inches and it is uncovered on the first dig.

They also sell a survey tool that is hand held and can be used to identify and find the general area of the leak. The cost of the survey tool is about $3,600.

They offer a training course that includes on site class room and field work for 4½ days; cost ~ $4,500

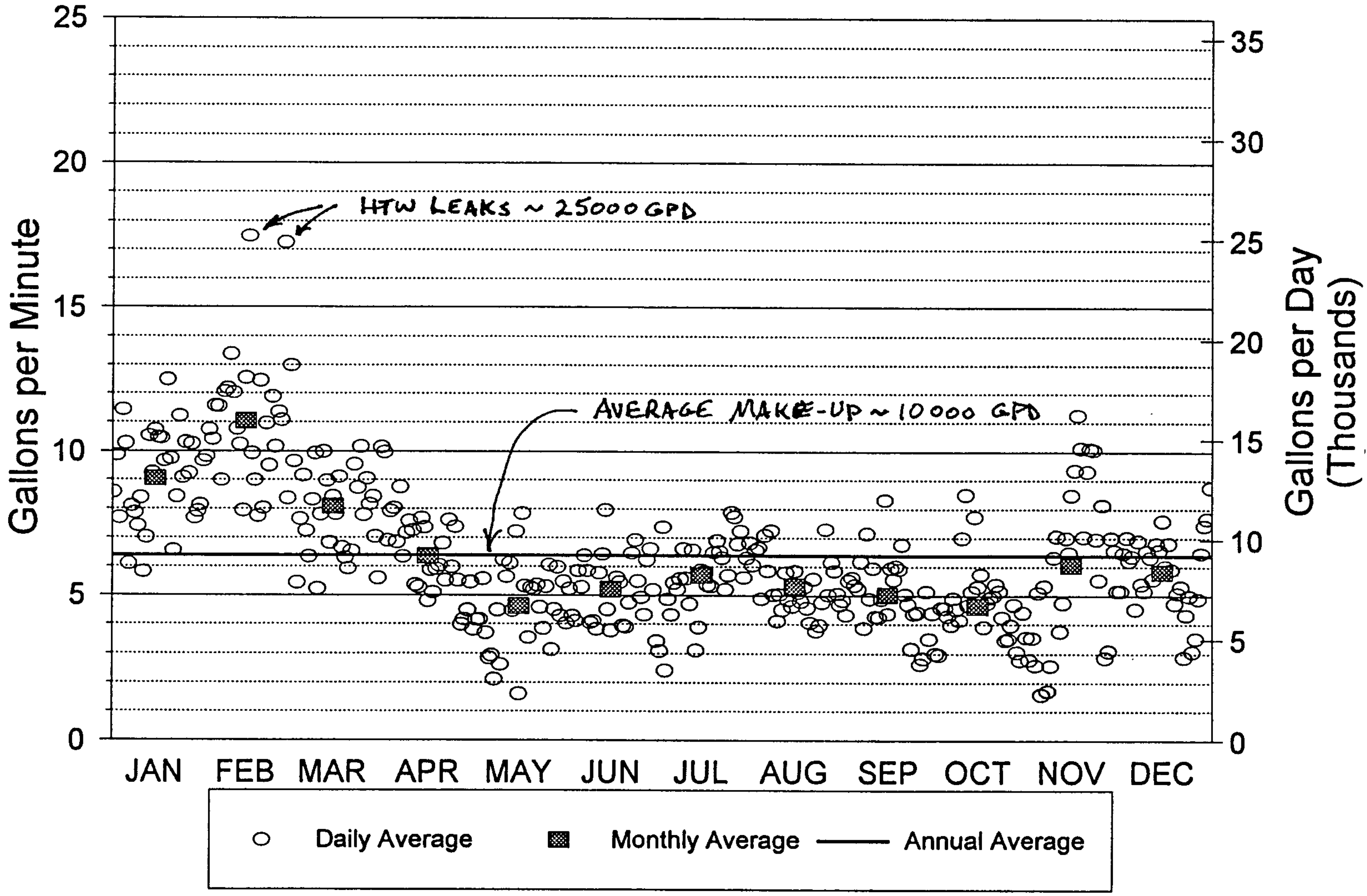
~~Distribution:~~

Tom also recommended Consumers Applied Technologies out of Orlando to do leak detection work. Contact Keith Nelson at 407·382·0995. He is also familar with USA group.

A.3.11-14

Figure 4.1-5

Fort Stewart HTW Make-up Water, 1995



SITE WORK

## 022 200 | Excav./Backfill/Compact.

| | | | CREW | DAILY OUTPUT | LABOR-HOURS | UNIT | 1996 BARE COSTS MAT. | LABOR | EQUIP. | TOTAL | TOTAL INCL O&P | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 204 | 0500 | Air tamp, add (A12.3-110) | B-9 | 190 | .211 | C.Y. | | 4.25 | .80 | 5.05 | 7.70 | 204 |
| | 0600 | Vibrating plate, add | A-1 | 60 | .133 | | | 2.64 | 1 | 3.64 | 5.30 | |
| | 0800 | Compaction in 12" layers, hand tamp, add to above | 1 Clab | 34 | .235 | | | 4.66 | | 4.66 | 7.45 | |
| | 0900 | Roller compaction operator walking, add | B-10A | 150 | .080 | | | 1.90 | .57 | 2.47 | 3.58 | |
| | 1000 | Air tamp, add | B-9 | 285 | .140 | | | 2.84 | .53 | 3.37 | 5.10 | |
| | 1100 | Vibrating plate, add | A-1 | 90 | .089 | | | 1.76 | .67 | 2.43 | 3.55 | |
| | 1300 | Dozer backfilling, bulk, up to 300' haul, no compaction | B-10B | 1,200 | .010 | | | .24 | .71 | .95 | 1.15 | |
| | 1400 | Air tamped | B-11B | 240 | .067 | | | 1.52 | 4.46 | 5.98 | 7.30 | |
| | 1600 | Compacting backfill, 6" to 12" lifts, vibrating roller | B-10C | 800 | .015 | | | .36 | 1.19 | 1.55 | 1.86 | |
| | 1700 | Sheepsfoot roller | B-10D | 750 | .016 | | | .38 | 1.29 | 1.67 | 2.01 | |
| | 1900 | Dozer backfilling, trench, up to 300' haul, no compaction | B-10B | 900 | .013 | | | .32 | .95 | 1.27 | 1.53 | |
| | 2000 | Air tamped | B-11B | 235 | .068 | | | 1.55 | 4.56 | 6.11 | 7.40 | |
| | 2200 | Compacting backfill, 6" to 12" lifts, vibrating roller | B-10C | 700 | .017 | | | .41 | 1.37 | 1.78 | 2.13 | |
| | 2300 | Sheepsfoot roller | B-10D | 650 | .018 | | | .44 | 1.49 | 1.93 | 2.32 | |
| 234 | 0010 | **DRILLING AND BLASTING** Only, rock, open face, under 1500 C.Y. | B-47 | 225 | .107 | C.Y. | 1.50 | 2.36 | 2.52 | 6.38 | 8.15 | 234 |
| | 0100 | Over 1500 C.Y. | " | 300 | .080 | | 1.50 | 1.77 | 1.89 | 5.16 | 6.50 | |
| | 2200 | Trenches, up to 1500 C.Y. | B-47 | 22 | 1.091 | | 4.50 | 24 | 25.50 | 54 | 71.50 | |
| | 2300 | Over 1500 C.Y. | " | 26 | .923 | | 4.29 | 20.50 | 22 | 46.79 | 60.50 | |
| 250 | 0010 | **EXCAVATING, STRUCTURAL** Hand, pits to 6' deep, sandy soil | 1 Clab | 8 | 1 | C.Y. | | 19.80 | | 19.80 | 31.50 | 250 |
| | 0100 | Heavy soil or clay | | 4 | 2 | | | 39.50 | | 39.50 | 63 | |
| | 0300 | Pits 6' to 12' deep, sandy soil | | 5 | 1.600 | | | 31.50 | | 31.50 | 50.50 | |
| | 0500 | Heavy soil or clay | | 3 | 2.667 | | | 53 | | 53 | 84.50 | |
| | 0700 | Pits 12' to 18' deep, sandy soil | | 4 | 2 | | | 39.50 | | 39.50 | 63 | |
| | 0900 | Heavy soil or clay | | 2 | 4 | | | 79 | | 79 | 126 | |
| | 1500 | For wet or muck hand excavation, add to above | | | | % | | | | 50% | 50% | |
| 254 | 0010 | **EXCAVATING, TRENCH** or continuous footing, common earth (A12.3-110) | | | | | | | | | | 254 |
| | 0020 | No sheeting or dewatering included | | | | | | | | | | |
| | 0050 | 1' to 4' deep, 3/8 C.Y. tractor loader/backhoe | B-11C | 150 | .107 | C.Y. | | 2.43 | 1.39 | 3.82 | 5.30 | |
| | 0060 | 1/2 C.Y. tractor loader/backhoe | B-11M | 200 | .080 | | | 1.82 | 1.43 | 3.25 | 4.41 | |
| | 0090 | 4' to 6' deep, 1/2 C.Y. tractor loader/backhoe | " | 200 | .080 | | | 1.82 | 1.43 | 3.25 | 4.41 | |
| | 0100 | 5/8 C.Y. hydraulic backhoe | B-12Q | 250 | .064 | | | 1.56 | 1.58 | 3.14 | 4.12 | |
| | 0110 | 3/4 C.Y. hydraulic backhoe | B-12F | 300 | .053 | | | 1.30 | 1.50 | 2.80 | 3.64 | |
| | 0300 | 1/2 C.Y. hydraulic excavator, truck mounted | B-12J | 200 | .080 | | | 1.95 | 3.15 | 5.10 | 6.45 | |
| | 0500 | 6' to 10' deep, 3/4 C.Y. hydraulic backhoe | B-12F | 225 | .071 | | | 1.73 | 2 | 3.73 | 4.86 | |
| | 0600 | 1 C.Y. hydraulic excavator, truck mounted | B-12K | 400 | .040 | | | .97 | 2.17 | 3.14 | 3.88 | |
| | 0900 | 10' to 14' deep, 3/4 C.Y. hydraulic backhoe | B-12F | 200 | .080 | | | 1.95 | 2.25 | 4.20 | 5.45 | |
| | 1000 | 1-1/2 C.Y. hydraulic backhoe | B-12B | 540 | .030 | | | .72 | 1.32 | 2.04 | 2.56 | |
| | 1300 | 14' to 20' deep, 1 C.Y. hydraulic backhoe | B-12A | 320 | .050 | | | 1.22 | 1.72 | 2.94 | 3.77 | |
| | 1400 | By hand with pick and shovel to 6' deep, light soil | 1 Clab | 8 | 1 | | | 19.80 | | 19.80 | 31.50 | |
| | 1500 | Heavy soil | " | 4 | 2 | | | 39.50 | | 39.50 | 63 | |
| | 1700 | For tamping backfilled trenches, air tamp, add | A-1 | 100 | .080 | | | 1.58 | .60 | 2.18 | 3.19 | |
| | 1900 | Vibrating plate, add | | 90 | .089 | | | 1.76 | .67 | 2.43 | 3.55 | |
| | 2100 | Trim sides and bottom for concrete pours, common earth | | 600 | .013 | S.F. | | .26 | .10 | .36 | .53 | |
| | 2300 | Hardpan | | 180 | .044 | " | | .88 | .33 | 1.21 | 1.77 | |
| 258 | 0010 | **EXCAVATING, UTILITY TRENCH** Common earth | | | | | | | | | | 258 |
| | 0050 | Trenching with chain trencher, 12 H.P., operator walking | | | | | | | | | | |
| | 0100 | 4" wide trench, 12" deep | B-53 | 800 | .010 | L.F. | | .25 | .11 | .36 | .50 | |
| | 0150 | 18" deep | | 750 | .011 | | | .26 | .11 | .37 | .52 | |
| | 0200 | 24" deep | | 700 | .011 | | | .28 | .12 | .40 | .56 | |
| | 0300 | 6" wide trench, 12" deep | | 650 | .012 | | | .30 | .13 | .43 | .61 | |
| | 0350 | 18" deep | | 600 | .013 | | | .33 | .14 | .47 | .66 | |
| | 0400 | 24" deep | | 550 | .015 | | | .36 | .15 | .51 | .72 | |
| | 0450 | 36" deep | | 450 | .018 | | | .44 | .19 | .63 | .88 | |
| | 0600 | 8" wide trench, 12" deep | | 475 | .017 | | | .42 | .18 | .60 | .84 | |





A.3.11-16

# FCS

FLUID CONSERVATION SYSTEMS

# TriCorr 2001

## Leak Correlator


The TriCorr 2001 is an advanced, portable microprocessor system for pinpointing fluid leaks in pressurized pipe systems.

It is the most advanced correlator on the market but is simple to operate and can be easily used by a single operator.

FCS specially designed the TriCorr 2001 for public and private water utilities, industrial and commercial water systems, engineering and service firms, and utility contractors.

---


## Typical Configuration

1. Correlator console with rechargeable battery
2. Two remote preamplifiers/radio links
3. Two high sensitivity sensors
4. 110 VAC battery charger
5. Stereo headphones
6. Cassette training tapes
7. Protective soft cases

12 VDC power cord/charger (not shown)
Operations manual (not shown)


## Additional Equipment

Sensor mounting kit
Hydrophones
Hydrophone attachment kit
Cable reels
Measuring wheel
Survey instrument
Pipe locator
Printer
Cassette recorder/player

## Size/Weight

| | |
|---|---|
| Length: | 14 inches |
| Depth: | 6 inches |
| Width: | 13 inches |
| Weight: | 14.5 lbs. (including soft cases and battery) |

## Power Supply

10V 2.5AH Battery

## Warranty

12 months parts and labor

Specifications subject to change.

A-3.11-18

# Features: Benefits

**Tri-Correlation:** simultaneous display of three correlation graphs simplifies evaluation of correlation results

**Peak Suppression:** eliminates interference on correlation graph

**Fast Fourier Transform (F.F.T.) Filtering:** provides real-time analysis and increased signal resolution

**True Signal Display:** provides real-time, visual leak signal verification

**Signal-to-Noise Display:** provides numerical and visual representation of correlation peaks

**Signal Spectrum Display:** focuses user toward potential leak frequencies via bar graph

**Velocity Calculation:** allows for accurate correlation if pipe material or diameter is unknown

**Multiple Pipe Type Diversity:** can correlate on up to 7 different pipe materials or diameters within the selected span

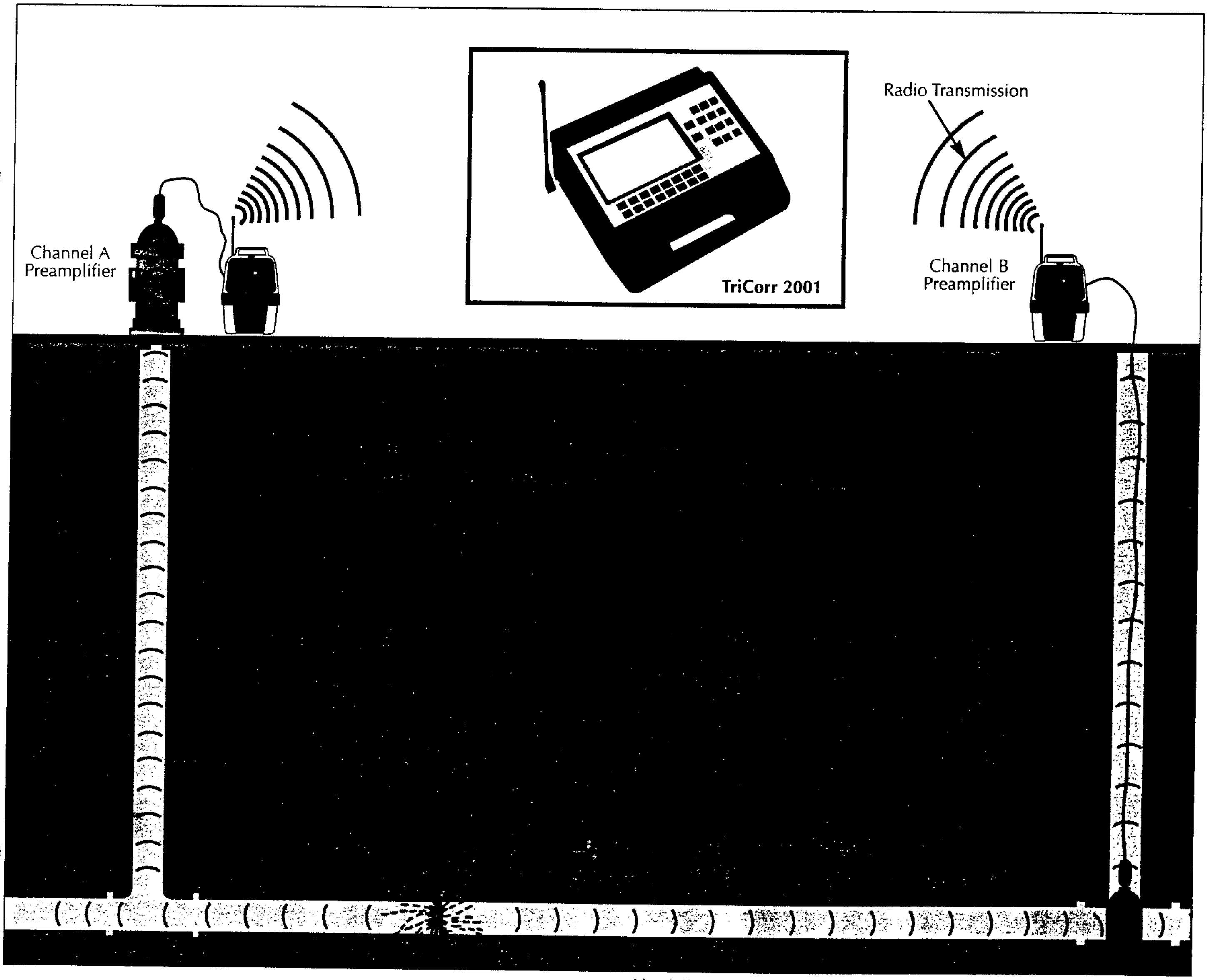
**Trial Correlation:** saves time/effort of correlating in insufficient leak signal situations

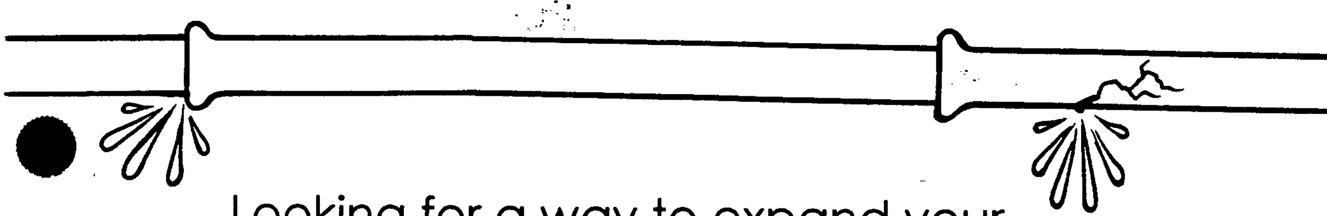
**Rugged Construction:** durable and effective in all field environments

**Easy-to-use Software:** easily used by all levels of personnel

**Large High Visibility LCD:** easy to read and interpret results

**Large Button/Water-Resistant Keypad:** can be used with gloves and in inclement weather





FCS
FLUID CONSERVATION SYSTEMS

Looking for a way to expand your leak detection program? Upgrading equipment?

Customize your own deal by choosing one of these three great options:

Purchase the TriCorr 2001 Leak Correlator at $51,500 and receive **FREE**:

- **1 S20 Leak Survey Tool**
- **4.5-Day Training Course**
- **1 Additional Year Warranty**

***...save $10,400!***

Purchase the TriCorr 2001 Leak Correlator at $51,500 and receive **FREE**:

- **3 Aqualogs** for unmanned leak detection, and
- **1 laptop computer** for down-loading the data.

***...save $16,570***

Or...***TRADE IT!***

We'll take **your** leak correlator (any make) as a trade-in, and give you $8,585 towards the purchase of a brand new TriCorr 2001 system!

***...save $8,585***

Call our sales department now at 800-531-5465 for information on this ***limited time offer!***

*offer expires 3/30/96*

**--The Water Accountability Specialists--**
Fluid Conservation Systems Inc.
2001 Ford Circle Suite F
Milford, Ohio 45150
(800) 531-5465 (513) 831-9336 fax

A HALMA GROUP COMPANY

A.3.11-20

progress quickly and easily through the logical software programme, using the inbuilt push button keypad, to obtain fast accurate results.

The central unit of rigid polyurethane construction is easily portable, weighing only $3^{1}/_{2}$ kg. Correlation results are displayed on the high contrast liquid crystal display, which is backlit for night time or poor visibility operation.

Filter and velocity settings are automatically allocated dependent on pipe type, diameter and other data entered. There is the option of manual filter choice, aided by audio monitoring using the studio quality headphones provided. Where pipe data is not available, velocity can be quickly and easily measured to ensure accuracy of results.

For a pipe run of mixed materials or diameter, the mixed material function allows data for different pipe sections to be entered. The system automatically compensates and chooses velocity and filter settings accordingly.

The zoom function reduces resolution errors by allowing detailed examination of specific sections of the correlator graphic. Results can be stored for later examination or printed on the portable thermal printer (available as an accessory).

## • MICROCORR CUB TECHNICAL SPECIFICATION •

**MicroCorr® Unit**

| | |
|---|---|
| Frequency response | 37-5000 Hz |
| Filters: high pass | 37,75,150,300,600 Hz |
| low pass | 310,625,1250,2500,5000 Hz |
| Max time delay | 1550 ms |
| Max theoretical range | 2.1km (iron pipe) 750m (pvc pipe) |
| Resolution | +\-0.1m |
| Display type | Backlit LCD |
| Battery supply | 12v lead acid |
| Battery life | 15 hours |
| Mixed materials | 3 sections |
| Printer | RS232 interface |
| Memory | 66 correlations |
| Construction | Rigid polyurethane |
| Dimensions | 330 x 230 x 145mm |
| Weight | 3.65kg |

**Features**

Battery level indication
Auto shutdown
Survey mode
Velocity measurement
Auto gain
Signal level display
Context related help
Language options
Download to PC
Real time clock/display

**Transmitter Unit**

| | |
|---|---|
| Transmitter range | 2000m |
| Level indication | Meter |
| Battery type | 12v lead acid 2.3 Ah |
| Battery level indication | Test switch |
| Battery life | 8 hours typical |
| Weight | 2.2kg |
| Dimensions | 140 x 165 x 300mm |
| Case construction | Rigid polyurethane |

**Features**

Top mounted controls
Auto gain
Interchangeable battery

**PALMER ENVIRONMENTAL**
Ty Coch House, Llantarnam Park Way, Cwmbran, Gwent NP44 3AW, United Kingdom
Telephone (01633) 489479 Int +44 1633 489479
Telefax (01633) 877857 Int +44 1633 877857

A HALMA GROUP COMPANY

A.3.11-21

TDA/4324/9.95/MP/1k

# ECO NUMBER 12

## REDUCE BOILER AND HTW SYSTEM OPERATING PRESSURE

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-12
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-12 REDUCE BOILER AND HTW SYSTEM PRESSURE
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT
A. CONSTRUCTION COST $ 0.
B. SIOH $ 0.
C. DESIGN COST $ 0.
D. TOTAL COST (1A+1B+1C) $ 0.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 0.
****** No investment costs; Other items should be checked. ******

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 0. | 15.08 | $ 0. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 30244. | $ 40527. | 14.88 | $ 603041. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 30244. | $ 40527. | | $ 603041. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 40527.

5. SIMPLE PAYBACK PERIOD (1G/4) .00 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 603041.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= ******
(IF < 1 PROJECT DOES NOT QUALIFY)

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-12
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-12 REDUCE BOILER AND HTW SYSTEM PRESSURE
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION B
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT
A. CONSTRUCTION COST $ 26657.
B. SIOH $ 1600.
C. DESIGN COST $ 1600.
D. TOTAL COST (1A+1B+1C) $ 29857.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 29857.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 0. | 15.08 | $ 0. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 53115. | $ 71174. | 14.88 | $ 1059071. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 53115. | $ 71174. | | $ 1059071. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 71174.

5. SIMPLE PAYBACK PERIOD (1G/4) .42 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 1059071.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 35.47
(IF < 1 PROJECT DOES NOT QUALIFY)

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-12
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-12 REDUCE BOILER AND HTW SYSTEM PRESSURE
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION C
ANALYSIS DATE: 08-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 26657. | | |
| B. SIOH | $ 1600. | | |
| C. DESIGN COST | $ 1600. | | |
| D. TOTAL COST (1A+1B+1C) | $ 29857. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 29857. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 0. | 15.08 | $ 0. |
| B. DIST | $ 4.40 | -26100. | $ -114840. | 18.57 | $ -2132579. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 110082. | $ 147510. | 14.88 | $ 2194947. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 83982. | $ 32670. | | $ 62369. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -24600.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -366048.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ -366048.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 8070.

5. SIMPLE PAYBACK PERIOD (1G/4) 3.70 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ -303680.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= -10.17
(IF < 1 PROJECT DOES NOT QUALIFY)

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WITH ECO-12A

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-12X
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-12 REDUCE BOILER AND HTW SYSTEM PRESSURE
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION B
ANALYSIS DATE: 02-15-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 26657. | | |
| B. SIOH | $ 1600. | | |
| C. DESIGN COST | $ 1600. | | |
| D. TOTAL COST (1A+1B+1C) | $ 29857. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 29857. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 13.74 | 0. | $ 0. | 15.08 | $ 0. |
| B. DIST | $ 4.40 | 0. | $ 0. | 18.57 | $ 0. |
| C. RESID | $ .00 | 0. | $ 0. | 21.02 | $ 0. |
| D. NAT G | $ .00 | 0. | $ 0. | 18.58 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 16.83 | $ 0. |
| F. PPG | $ .00 | 0. | $ 0. | 17.38 | $ 0. |
| L. OTHER | $ 1.34 | 22871. | $ 30647. | 14.88 | $ 456029. |
| M. DEMAND SAVINGS | | | $ 0. | 14.88 | $ 0. |
| N. TOTAL | | 22871. | $ 30647. | | $ 456029. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 30647.

5. SIMPLE PAYBACK PERIOD (1G/4) .97 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 456029.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 15.27
(IF < 1 PROJECT DOES NOT QUALIFY)

| | | | |
|---|---|---|---|
| **RS&H** | SUBJECT: FORT STEWART<br>REDUCE OPERATING PRESSURE | AEP NO: 694 1331 002 | SHEET: 1 OF |
| | DESIGNER: G. Fallon | DATE: 2-13-96 | |
| | CHECKER: | DATE: | |

ECO-12 REDUCE HTW PRESSURE

OPTION A. REDUCE PRESSURE FROM 180 TO 100 PSIG

SATURATION TEMPERATURE FOR 180 PSIG = 379°F

" " " 100 " = 338°F

TOTAL LINEAL FT OF PIPE = 121737 FT

LINEAL HEAT LOSS GOOD PIPE = 55 BTU/FT (see attached)

" " " BAD PIPE = 275 BTU/FT (" ")

ASSUME 1/2 OF THE PIPE IS GOOD & 1/2 IS BAD.

SEP LINEAL FT OF PIPE = 17500 FT

ENERGY SAVED IN HTW DISTRIBUTION SYSTEM

$$q_{CEP} = \frac{\left(1-\frac{(338-60)}{(379-60)}\right)\times(121737-17500)\,ft \times \frac{(275+55)}{2}\,BTU/HR\cdot FT \times 8760\,H/yr}{1E6\ BTU/MBTU}$$

$= 19,364$ MBTU/yr

$$Q_{SEP} = \left(1-\frac{(338-60)}{(379-60)}\right) \times 17500\ ft \times \frac{275-55}{2}\,BTU/HR\cdot FT \times 135\,D/yr \times 24\,H/D$$

$= 1202$ MBTU/yr

$$Q_{TOT} = \frac{q_{CEP}+Q_{SEP}}{0.68}$$ NOTE: ASSUME 68% BOILER Eff.

$$= \frac{(19364+1202)\ MBTU/yr}{0.68} = \frac{20566}{0.68}\ MBtu/YR$$

$$= \boxed{30{,}244\ MBTU/yr}$$

NOTE: THIS OPTION CAN BE IMPLEMENTED IMMEDIATELY BY RESETTING THE CEP STEAM PRESSURE MASTER CONTROL SET POINT TO 100 PSIG.

ANNUAL SAVINGS

$ = 30,244 MBTU/yr × 1.34 $/MBTU

= 40,527 $/yr

**RS&H**

SUBJECT FORT STEWART
REDUCE OP. PRESSURE
DESIGNER G. Fallon
CHECKER

AEP NO 694 1331 002
SHEET 2 OF
DATE 2-13-96
DATE

ECO 12 CONT. REDUCE HTW PRESSURE

OPTION B: REDUCE PRESSURE TO 60 psig
SATURATION TEMPERATURE FOR 60psig = 307 °F
NOTE: 60psig WAS CHOSEN BECAUSE THE AUTOCLAVES IN THE HOSPITAL REQUIRE 50-80 psig STEAM.

ENERGY SAVED IN DISTRIBUTION SYSTEM

$$Q_{CEP} = \frac{\left(1-\frac{(307-60)}{(379-60)}\right) \times (121737-17500)\,ft \times \frac{(275+55)}{2}\,BTU/hr \cdot ft \times 8760\ HR/yr}{1E6\ BTU/MBTU}$$

$$= 34{,}006\ MBTU/yr.$$

$$Q_{SEP} = \frac{\left(1-\frac{(307-60)}{(379-60)}\right) \times (17500)\,ft \times \frac{(275+55)}{2}\,BTU/HR \cdot FT \times 135\ D/yr \times 24\ H/D}{1E6\ BTU/MBTU}$$

$$= 2112\ MBTU/yr$$

$$Q_{TOT} = \frac{Q_{CEP} + Q_{SEP}}{0.68}$$

$$= \frac{(34006 + 2112)}{0.68}\ MBTU/yr$$

$$= \boxed{53{,}115\ MBTU/yr}$$

ANNUAL COST SAVINGS

SAVINGS = 53,115 MBTU/yr × 1.34 \$/MBTU
= 71,174 \$/yr

| | | | |
|---|---|---|---|
| **RS&H** | SUBJECT FORT STEWART<br>Reduce Op. Pressure | AEP NO 694 1331 002 | |
| | DESIGNER G. Fallon | SHEET 3 OF | |
| | CHECKER | DATE 2-13-96 | |
| | | DATE | |

ECO 12 CONT. REDUCE HTW PRESSURE

OPTION B (CONTINUED)

THE BOILER PRESSURE MUST REMAIN AT APPROXIMATELY 100 PSIG TO SUPPLY ITS OWN SOOT BLOWING PRESSURE.

A PRESSURE REDUCING STATION MUST BE PROVIDED TO REDUCE THE STEAM PRESSURE FROM 100 PSIG TO 60 PSIG. THE PRESSURE REDUCING STATION INCLUDES:

- 1 PRV W/ PNEUMATIC ACTUATOR
- 1 PRESSURE TRANSMITTER
- 1 PRESSURE CONTROLLER W/SET POINT ADJUSTMENT.

INSTALLATION COST

SEE ESTIMATE SHEET.

ECO 12 CONT. REDUCE HTW PRESSURE

OPTION C: REDUCE PRESSURE TO 30 psig. THE STEAM KETTLES IN THE DINING FACILITIES OPERATE ON 30 psig STEAM. AN ALTERNATE HEATING TECHNIQUE WILL HAVE TO BE INSTALLED IN THE HOSPITAL TO SUPPLY THE AUTOCLAVES.

ENERGY SAVED IN DISTRIBUTION SYSTEM

$$Q_{CEP} = \frac{\left(1-\frac{(274-60)}{(379-60)}\right) \times (121737-17500)\,ft \times \frac{(275+55)}{2}\,BTU/ft\,HR \times 8760\ Hr/yr}{1E6\ BTU/mBTU}$$

$$= 49{,}592\ mBTU/yr$$

$$Q_{SEP} = \frac{\left(1-\frac{(274-60)}{(379-60)}\right) \times (17500)\,ft \times \frac{(275+55)}{2}\,BTU/ft\,HR \times 135\ D/y \times 24\ H/D}{1E6\ BTU/mBTU}$$

$$= 3079\ mBTU/yr$$

$$Q_{TOT} = Q_{CEP} + Q_{SEP}$$

$$= \frac{(49{,}592 + 3079)\ mBTU/yr}{0.68}$$

$$= \underline{77{,}457\ mBTU/yr}$$

ANNUAL COST SAVINGS FROM DISTRIBUTION SYSTEM

$$SAVINGS = 77457\ mBTU/yr \times 1.34\ \$/mBTU$$

$$= 103{,}793\ \$/yr$$

ENERGY REQUIRED IN HOSPITAL

ASSUME 5 AUTOCLAVES @ 60 psig, 1000 #/HR, 12 H/D 365 D/yr 85% BOILER EFF.

**RS&H**

SUBJECT FORT STEWART
Reduce Op. Pressure
DESIGNER G. Fallon
CHECKER

AEP NO 694 1331 002
SHEET 5 OF
DATE 2-13-96
DATE

ECO - 12 CONT. REDUCE HTW PRESSURE

OPTION C: (CONTINUED)

$$Q = \frac{5 \times 1000 \text{ \#/HR} \times (1181 - (200-32)) \times 4380 \text{ HR/YR}}{0.85 \times 1E6 \text{ B/mB}} = \frac{22185 \text{ mBtu/YR}}{0.85}$$

$$= \underline{26{,}100} \text{ mBTU/yr Additional Fuel Oil}$$

ANNUAL COST

$$\text{COST} = 26100 \text{ mBTU/yr} \times (4.40 - 1.34/0.68) \text{ \$/mBTU}$$

$$= \$63{,}408/\text{yr}$$

TOTAL ENERGY SAVINGS (INCREASE)

$$\text{HTG. FUEL} = 77457 \text{ mBTU/yr} + \frac{22185}{0.68} \text{ mBtu/YR} = \boxed{110082 \frac{\text{mBtu}}{\text{YR}}}$$

$$\text{FUEL OIL} = \boxed{(26{,}100) \text{ mBTU/yr.}}$$

NET COST SAVINGS

$$S_c = \$103{,}793/\text{yr} - \$63{,}408/\text{yr.}$$

$$= \$40385/\text{yr}$$

RS&H

SUBJECT Fort Stewart HTW
Boiler O+M Costs
DESIGNER W. Todd
CHECKER

AEP NO 694 1331 002
SHEET ____ OF ____
DATE 8-13-96
DATE

HOSPITAL BOILER O&M COSTS:

IF THE HOSPITAL BOILERS ARE OPERATED, THEY WILL REQUIRE AN OPERATOR / MAINTENANCE PERSON TO TEND AND REPAIR THEM. ASSUME THE TIME REQUIRED FOR O&M AVERAGES ABOUT $1\frac{1}{2}$ HOUR PER SHIFT, 365 DAYS PER YEAR.

$$O\&M\ TIME = 1.5\ ^{HR}/_{SHIFT} \times 3\ ^{SHIFT}/_{DAY} \times 365\ ^{DAY}/_{YR} \approx 1640\ ^{HR}/_{YR}$$

USING A RATE OF \$15 PER HOUR, THE ANNUAL O&M COSTS ARE:

$$O\&M\ \$ = 1640\ ^{HR}/_{YR} \times \$15/_{HR} = \underline{\$24{,}600/_{YR}}$$



9/96

RS&H.

| | |
|---|---|
| SUBJECT FORT STEWART | AEP NO 694 1331 002 |
| Reduce Op. Pressure | SHEET 7 OF |
| DESIGNER G. Fallon | DATE 2-13-96 |
| CHECKER | DATE |

CURRENT PIPING ENERGY LOSS

$Q_{CEP} = (121737 - 17500)\,ft \times (275+55)/2\ BTU/HR \cdot ft \times 8760$

$104237 \times 165 \times 8760$

$= 150{,}664\ mBTU/yr$

$Q_{SEP} = (17500)\,ft \times (275+55)/2\ BTU/HR \cdot ft \times 135 \times 24$

$= 9355\ mBTU/yr$

$Q_{TOT} = 150{,}664\ mBtu/YR + 9355\ mBtu/YR = 160019\ mBtu/YR$

Current fuel use $= 160{,}019\ \frac{mBtu}{YR} \div 0.68 = 235{,}322\ \frac{mBtu}{YR}$

RS&H

SUBJECT FORT STEWART

DESIGNER W.T. TODD

CHECKER

AEP NO 694-1331-002

SHEET ____ OF ____

DATE 2-19-96

DATE

OPERATE HTW SYSTEM AT LOWER PRESSURES

AFFECT ON OTHER ECO'S

| OP. PRESSURE | HTW TEMP. | $\Delta T$ (1) | HEAT LOSS (2) |
|---|---|---|---|
| 180 PSIG | 380 °F | 310 °F | 258.7 $\frac{MBtu}{YR}$ |
| 100 PSIG | 338 °F | 268 °F | 223.6 $\frac{MBtu}{YR}$ |
| 60 PSIG | 307 °F | 237 °F | 197.8 $\frac{MBtu}{YR}$ |

(1) Based on HTW make-up water temperature of 70 °F.
(2) See spreadsheet calculations on following 3 pages. Loss is for fictitious loss of 100,000 Gal/year.

All ECO's that reduce the HTW losses will be affected by operation at lower pressures. The energy savings for these ECO's will be reduced by the following amounts:

180 PSIG → 100 PSIG :

$$\% \text{ Change} = \frac{257.8 - 223.6}{257.8} \Rightarrow \underline{13.57\ \%}$$

100 PSIG → 60 PSIG :

$$\% \text{ Change} = \frac{223.6 - 197.8}{223.6} \Rightarrow \underline{11.54\ \%}$$

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. | |
| AEP Number: | 694-1331-002 | Designer: | W. T. Todd |
| Project: | Existing Conditions | Date: | 02/19/96 |
| ECO Number: | All | | |

Assumptions:

| | | | |
|---|---|---|---|
| 1. | HTW temperature | 380 | °F |
| 2. | Make-up water temperature | 70 | °F |
| 3. | Boiler efficiency | 68% | |
| 4. | Pump head (from record drawings) | 300 | Ft H20 |
| 5. | Pump efficiency (from record drawings) | 72% | |
| 6. | Motor efficiency | 90% | |
| 7. | Average heating fuel cost | $1.34 | /MBtu |
| 8. | Electricity cost | $0.0469 | /kWh |
| 9. | Water cost | $0.5562 | /kGallons |

Energy Loss Calculations:

Energy Use = flow rate x specific heat x temperature difference

100000 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 258.7 MBtu/Yr

Heating Fuel Use = 258.7 MBtu/yr / 0.68 = 380.4 MBtu/Yr

Heating Fuel Cost = 380.4 MBtu/yr x $1.34 /MBtu = $510 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$BHP = \frac{0.19 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.02 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency ) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.02 BHP / 0.90 x 0.746 kW/HP = 0.02 kW

Electricity Use = 0.02 kW x 8760 Hr/Yr = 145 kWh/Yr

Electricity Cost = 145 kWh/Yr x $0.0469 /kWh = $7 /Year

Water Cost:

100000 Gal/Yr x $0.5562 /kGal = $56 /Year

Total Utility Cost Savings:

| | | |
|---|---|---|
| Heating Fuel Cost | $510 | /Year |
| Pumping (Elec) Cost | $7 | /Year |
| Water Cost | $56 | /Year |
| Total Savings | $573 | /Year |

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. | |
| AEP Number: | 694-1331-002 | Designer: | W. T. Todd |
| Project: | With ECO-12 Option A | Date: | 02/19/96 |
| ECO Number: | All | | |

Assumptions:

| | | |
|---|---|---|
| 1. HTW temperature | 338 | °F |
| 2. Make-up water temperature | 70 | °F |
| 3. Boiler efficiency | 68% | |
| 4. Pump head (from record drawings) | 300 | Ft H20 |
| 5. Pump efficiency (from record drawings) | 72% | |
| 6. Motor efficiency | 90% | |
| 7. Average heating fuel cost | $1.34 | /MBtu |
| 8. Electricity cost | $0.0469 | /kWh |
| 9. Water cost | $0.5562 | /kGallons |

Energy Loss Calculations:

Energy Use = flow rate x specific heat x temperature difference

100000 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 268 °F = 223.6 MBtu/Yr

Heating Fuel Use = 223.6 MBtu/yr / 0.68 = 328.9 MBtu/Yr

Heating Fuel Cost = 328.9 MBtu/yr x $1.34 /MBtu = $441 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$BHP = \frac{0.19\ \text{GPM} \times 300\ \text{Ft Head}}{3960 \times 0.72} = 0.02\ \text{BHP}$$

Energy Use = (BHP / Motor Efficiency ) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.02 BHP / 0.90 x 0.746 kW/HP = 0.02 kW

Electricity Use = 0.02 kW x 8760 Hr/Yr = 145 kWh/Yr

Electricity Cost = 145 kWh/Yr x $0.0469 /kWh = $7 /Year

Water Cost:

100000 Gal/Yr x $0.5562 /kGal = $56 /Year

Total Utility Cost Savings:

| | | |
|---|---|---|
| Heating Fuel Cost | $441 | /Year |
| Pumping (Elec) Cost | $7 | /Year |
| Water Cost | $56 | /Year |
| Total Savings | $504 | /Year |

| | | | |
|---|---|---|---|
| Location: | Fort Stewart, GA | Reynolds, Smith and Hills, Inc. | |
| AEP Number: | 694-1331-002 | Designer: | W. T. Todd |
| Project: | With ECO-12 Option B | Date: | 02/19/96 |
| ECO Number: | All | | |

Assumptions:

| | | |
|---|---|---|
| 1. HTW temperature | 307 | °F |
| 2. Make-up water temperature | 70 | °F |
| 3. Boiler efficiency | 68% | |
| 4. Pump head (from record drawings) | 300 | Ft H20 |
| 5. Pump efficiency (from record drawings) | 72% | |
| 6. Motor efficiency | 90% | |
| 7. Average heating fuel cost | $1.34 | /MBtu |
| 8. Electricity cost | $0.0469 | /kWh |
| 9. Water cost | $0.5562 | /kGallons |

Energy Loss Calculations:

Energy Use = flow rate x specific heat x temperature difference

100000 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 237 °F = 197.8 MBtu/Yr

Heating Fuel Use = 197.8 MBtu/yr / 0.68 = 290.8 MBtu/Yr

Heating Fuel Cost = 290.8 MBtu/yr x $1.34 /MBtu = $390 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$\text{BHP} = \frac{0.19 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.02 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.02 BHP / 0.90 x 0.746 kW/HP = 0.02 kW

Electricity Use = 0.02 kW x 8760 Hr/Yr = 145 kWh/Yr

Electricity Cost = 145 kWh/Yr x $0.0469 /kWh = $7 /Year

Water Cost:

100000 Gal/Yr x $0.5562 /kGal = $56 /Year

Total Utility Cost Savings:

| | | |
|---|---|---|
| Heating Fuel Cost | $390 | /Year |
| Pumping (Elec) Cost | $7 | /Year |
| Water Cost | $56 | /Year |
| Total Savings | $453 | /Year |

# CONSTRUCTION COST ESTIMATE

Project: Reduce Operating Pressure
Location: Fort Stewart, GA
Basis: Schematic Design
ECO No.: 12

RS&H No.: 694-1331-002
Date: 02/14/96
Estimator: G.W. Fallon
Filename: EST-12.WQ1

| ITEM DESCRIPTION | QUANTITY No. | QUANTITY Unit | MATERIAL/EQUIP $/Unit | MATERIAL/EQUIP Total | LABOR $/Unit | LABOR Total | TOTAL COST | SOURCE Material | SOURCE Labor |
|---|---|---|---|---|---|---|---|---|---|
| Pressure Reducing Station, w/ controls | 1 | ea | 22233 | 22233 | 305 | 305 | 22,538 | Vendor | MMp192 |
| 300 lb flange, 10" dia Weld Neck | 2 | ea | 220 | 440 | 145.5 | 291 | 731 | MMp165 | MMp165 |
| Welding Labor | 2 | ea | 0 | 0 | 123.15 | 246 | 246 | | MMp144 |
| Subtotal Bare Costs | | | | 22673 | | 842 | $23,515 | | |
| Retrofit Cost Factors | | | 0% | 0 | 0% | 0 | 0 | MMp6 | MMp6 |
| Subtotal | | | | 22673 | | 842 | 23,515 | | |
| City Cost Index (Sav. GA) | | | 0% | 0 | -44% | -372 | (372) | MMp533 | MMp533 |
| Subtotal | | | | 22673 | | 470 | 23,143 | | |
| OH & Profit Markups | | | 10% | 2267 | 53% | 249 | 2,516 | MMp7 | MMp475 |
| Subtotal | | | | 24940 | | 719 | 25,659 | | |
| Sales Taxes | | | 4.0% | 998 | | NA | 998 | MMp476 | |
| Total Construction Cost | | | | 25938 | | 719 | 26,657 | | |
| Design Fee | | | | NA | 6.0% | 1599 | 1,599 | | |
| SIOH | | | | NA | 6.0% | 1599 | 1,599 | | |
| Subtotal | | | | 25938 | | 3917 | 29,855 | | |
| Contingency | | | 0% | 0 | 0% | 0 | 0 | MEp6 | MEp6 |
| Total Project Cost | | | | 25938 | | 3917 | $29,855 | | |

LEGEND:
Vendor — Telephone/fax quote from manufacturers rep.
MMp### — 1996 Means Mechanical Cost Data, page ###.

**FISHER·ROSEMOUNT**

Key Controls Inc.
Jacksonville Branch
1409 Kingsley Ave. Suite 7B
Orange Park, Florida 32073-4532
Tel 1 (904) 269-5455
Fax 1 (904) 269-5446

February 13, 1996

Reynolds, Smith & Hills Inc.
4651 Salisbury Rd.
Jacksonville, FL 32216

Attn: George Fowler

RE: Budgetary Proposal Steam Pressure Control Valve; Key Controls' Quotation #96-32080

Dear Mr. Fowler:

Thank you for your inquiry. As per your conversations with Wes King, we are pleased to quote budgetary pricing on the following Fisher Controls' products.

Item 1 Qty. 1

8" x 6" Fisher Type EWD globe control valve. ANSI Class 300# carbon steel body, 416 SST seat ring, 17-4PH SST plug, 416 SST Whisper III cage. Operated by a Fisher Type 471-16, size 60, pneumatic double-acting piston actuator, and Fisher Type 3570 pneumatic valve positioner. 60 psig actuator supply. 3-15 psig positioner input. Increasing signal to open. An external fail-safe device would be required to achieve failure for this valve. Also includes Fisher Type 4195KB, proportional-plus reset pneumatic controller. 300 psig bourdon tube element. With 2" pipestand mounting.

UNIT PRICE = $ 22,233.30
ESTIMATED DELIVERY = 10-12 WKS ARO

Pricing for this estimate is firm for 30 days from today's date, and is quote FOB shipping point, with surface freight allowed to jobsite.

Please find enclosed a control valve specification sheet, detailing valve construction and selected service conditions. If you have any further questions, please contact Tom Glaspie or Wes King at your convenience.

Sincerely yours,

Wesley A. King

Wes King

**Fisher Controls**

# Control Valve Specification

FISHER

Customer: G. Fowler
Reference: Fort Stewart
Order No: —
Quote No:
Date 2/13/96 Page 1 of 1

| | | |
|---|---|---|
| Item | | 1 |
| Quantity | | 1 |
| Application | | Steam Press. Control |
| Tag | | |
| Size and Type | | 8"x6" 470-16-EWD |
| Body | Style | ☒ Globe ☐ Angle ☐ |
| | End Connections | ☐ Scrd ☐ SWE ☒ Flg 300 ANSI RF ☐ BWE Schedule Casting Rating ☐ |
| | Material | ☐ Iron ☐ 316 SST ☒ Steel ☐ |
| | Number of Ports | ☒ One ☐ Two |
| | Push Down to | ☒ Close ☐ Open |
| | Flow Direction | ☐ Down ☒ Up |
| Trim | Trim Number | 301 |
| | Cage or Retainer Material | 416SS Whisper III |
| | Bushing Material | — |
| | Seat Ring Material | 416SS |
| | Valve Plug Material | 17-4 ph SS |
| | Valve Plug Guiding | ☒ Cage ☐ Top ☐ Stem ☐ Port ☐ Top & Bottom |
| | Valve Plug Balance | ☒ Balanced ☐ Unbalanced |
| | Port Size | ☐ Full ☒ 5 3/8 |
| | Characteristic | ☐ Quick-Opening ☒ Linear ☐ Equal-Percentage ☐ |
| | Shutoff Class | ☒ Standard ☐ |
| Bonnet | Style | ☒ Std ☐ Ext. # |
| | Boss Size | ☒ Std ☐ |
| | Packing | ☒ TFE ☐ Lubr & Isol Valve ☐ TFE Asb ☐ ☐ Lam Graphite |
| | Bolting Bonnet | ☒ Std ☐ |
| | Bolting Pack. Flg. | ☒ Std ☐ |
| Actuator | Style | ☒ Piston ☐ Diaph ☐ |
| | Size | 60 |
| | Air to Actuator | ☐ 3 to 15 ☐ 6 to 30 ☒ 60 |
| | Air Fails Valve to | ☐ Close ☐ Open ☐ Lock |
| | Handjack | ☐ Top ☐ Side |

| | | |
|---|---|---|
| Positioner | Type | ☐ 3582 ☐ 3590 ☒ 3570 |
| | Input Signal | ☒ 3 to 15 psi ☐ 4 to 20 mA ☐ 6 to 30 psi ☐ 10 to 50 mA ☐ ☐ |
| | Accessories | ☒ Airset ☒ Gauges ☐ Bypass |
| | Increase Signal Valve | ☐ Closes ☒ Opens |
| I/P Positioner Only | Certification† | ☐ None |
| | Explosion-proof | ☐ CSA |
| | Intrinsically safe | ☐ FM ☐ CSA |
| Controller | Type | 4195KB |
| | Action | ☒ Direct ☐ Reverse |
| | Measuring Element | ☒ Bourdon Tube ☐ Bellows Range 360 Psig; ☐ Bronze ☐ Steel ☒ SST |
| | Output (Psig) | ☒ 3 to 15 ☐ 6 to 30 ☐ |
| | Mounting | ☐ Yoke ☐ Csg ☒ Remote |
| | Airset | ☒ 67AFR-221 ☐ |
| | Airset Mounting | ☐ Yoke ☒ Nipple |
| 546 Transducer | Input Signal (mA) | ☐ 10 to 50 ☐ 4 to 20 ☐ |
| | Output Signal (Psig) | ☐ 3 to 15 ☐ 6 to 30 ☐ |
| | Action | ☐ Direct ☐ Reverse |
| | Mounting | ☐ Yoke ☐ Csg ☐ Pipe |
| | Airset | ☐ 67AFR-362 ☐ |
| | Certification† | ☐ None |
| | Explosion-proof | ☐ FM ☐ CSA |
| | Intrinsically safe | ☒ FM ☐ CSA |

**Service Conditions**

☒ Throttling ☐ On-Off ☐ PRV ☐ Relief

| | 1 | 2 | 3 |
|---|---|---|---|
| Flowing Media | Sat. Steam | | |
| Specific Gravity | | | |
| Inlet Temperature °F | | 400 | |
| Inlet Pressure (Psig) | 100 | 100 | 200 |
| Inlet Vapor Pressure | | | |
| ΔP Sizing (Psi) | 85 | 40 | 140 |
| ΔP Shutoff (Psi) | | 200 | |
| Flow Rate, Give Units #/hr | 100,000 | 100,000 | 100,000 |
| Req'd Flow Coeff., ☐ $C_v$ ☒ $C_g$ ☐ $C_s$ | 13,146 | 15,181 | 9695 |
| Valve Coefficient | | 15,500 | |
| Recovery Coeff., ☐ $K_m$ ☒ $C_1$ | | 33.7 | |
| Noise Level (dBA) | 98.6 | 92.9 | 87.2 |
| Line Size (in.) | | 8" STD | |

Worksheet

Notes and/or Special Constructions

PREPARED BY: WK
DATE: 2/13/96
KEY CONTROLS INC.
1409 KINGSLEY AVE.
ORANGE PARK, FL 32073

| | | |
|---|---|---|
| Approximate Shipping Weight, Lb. | List Price | $ |
| | Unit Net Price | $ |
| | Total Net Price | $ |

† Please insure proper certification requirements or barrier interface before entering order. See Hazardous Area Certifications Bulletin 9.2:001.

Form 2861D

A.3.12-20

CONF-8406132--2



# ANALYSIS OF A SMALL DISTRICT STEAM SYSTEM AT FT. McCLELLAN, ALABAMA

CONF-8406132

DE84 014051

Gerald D. Pine and Michael A. Karnitz

Energy Division
Oak Ridge National Laboratory*
Oak Ridge, Tennessee 37831

615 576-5454
574-5150

For presentation at the
75th Annual Conference of the International
District Heating Association
Mount Washington, New Hampshire

June 17-20, 1984

MASTER



*Research sponsored by the U. S. Army, Construction Engineering Research Laboratory, under Interagency Agreement Number 40-1361-83, Army Number CERL-83-080, operated by Martin Marietta Energy Systems, Inc., under Contract No. DE-AC05-84OR21400 with the U.S. Department of Energy.



A.3.12-21

Of the total steam produced, we estimate that approximately 95% enters the steam distribution system. The remaining 5% is used within the boiler plants to power auxiliaries. This amounts to some 570 lb/hr on the average or 5.0 million lb/yr. Then approximately 96 million lb/yr enters the distribution system.

## 5. CAUSES FOR HEAT LOSS FROM BURIED PIPE

In order to minimize heat losses from steam and condensate pipe lines, the lines are usually insulated. Sometimes the pipes may run above ground but more commonly, the pipes are buried from two to six feet below the surface. If the insulation is intact and dry, the ground helps to insulate the pipe from cold temperatures in the winter and to reduce the heat losses. In this section, we present estimates of the heat losses for well insulated pipes as well as for pipes with deteriorated insulation and under various failure conditions.

Heat Loss From Dry, Insulated, Buried Pipes. Heat losses have been calculated for varied soil conditions and various types of insulation by King et. al. [3]. For the example of a six-inch steam line at 325°F with four inches of calcium silicate insulation in clay of average moisture and a soil temperature of 50°F, the rate of heat loss would be approximately 55 Btu/hour per linear foot of pipe. For the Ft. McClellan system with a steam temperature of 338°F and a ground temperature of 80°F, the loss rate would be about 52 Btu/hr-ft.

Heat Loss From Bare Pipes in Air. The simplest case to consider is a bare pipe exposed to ambient air on a dry, still day. For this case, the two major heat loss mechanisms are natural convection and radiation. We consider the case of a six-inch pipe with 338°F steam and ambient air at 150°F (a typical temperature inside a dry vault, where much of the bare pipe is found). The estimated loss due to natural convection under these conditions is about 350 Btu/hour per foot of pipe. Kreith [4] in Table 5.1 gives a value of emissivity of 0.8 for oxidized steel pipe. For the same pipe, the estimated radiation loss is approximately 570 Btu/hr-ft. The total loss per foot of bare pipe under these circumstances is then 920 Btu/hr-ft.

Buried Pipes With Entrapped Moisture and Deteriorated Insulation. Observations of actual buried steam lines indicates that the heat losses are substantially higher than the theoretical losses. Consideration of the magnitudes of the observed losses suggests that the pipe is behaving as though there were no insulation, and that the pipe is in direct contact with the surrounding soil. The most likely physical explanation is that the conductivity has been greatly enhanced by the deterioration of the insulation from the combined effects of heat and moisture that gets into the system by steam leaks or the intrusion of ground water. Entrapped moisture could be boiling near the surface of the pipe and condensing on the jacket, or subcooled boiling and the formation of a thermal convection loop in water filling the space between the pipe and jacket could be occurring. Both these processes produce extremely high heat transfer rates compared to the rate through dry insulation. If it is assumed that the conductivity of the insulation is infinite, the model of King et al. yields a heat transfer factor of about 1.8 Btu/hr-°F per foot of six-inch diameter pipe. For the six-inch pipe at 338°F and a 80°F ground temperature, the rate of heat loss per foot of pipe would be 460 Btu/hr-ft. This compares with the observed value of about 275 Btu/hr-ft.

Heat Loss From Flooding of Vaults. A commonly observed failure of steam lines is the failure of sump pumps in valve pits and the subsequent covering of the steam pipe with water. The source of the water can be either condensate from steam traps, which collects in the vault and causes flooding when sump pumps fail, or intrusion of ground water into the pits through cracks in the pit wall or around pipes that penetrate the pit walls. Water in the vaults is commonly heated to temperatures that are rather hot; we assume here that the water in the vault is heated to 150°F. The estimated rate of heat loss from a bare, six-inch steam pipe carrying 338°F steam and covered by 150°F water is 50,000 Btu/hr-ft. (This estimate could be higher, perhaps as high as 150,000 Btu/hr-ft depending on the assumed heat transfer mechanism.) Notice that the loss is nearly sixty times as large as the loss from dry, bare pipe. Perhaps even more interesting, the rate of heat loss would be 190 times greater than the

# A.4 HTW LOSS CALCULATIONS

Fort Stewart - Measured/Estimated HTW Leaks
Filename: F-MAKEUP.WB2

| WATER LOSS ESTIMATE | | |
|---|---|---|
| ITEM | GPD | GPM |
| 1) Boiler & Cascade Blowdown | 1440 | 1.00 |
| 2) Sootblowing - Boiler No. 4 | 468 | 0.33 |
| 3) CEP - Miscellaneous Leaks | 302 | 0.21 |
| 4) CEP - No. 4 Boiler Pipe & Fitting | 323 | 0.22 |
| 5) SEP - Miscellaneous Leaks | 336 | 0.23 |
| 6) Valve Pit Leaks - Valves & Fitting | 1398 | 0.97 |
| 7) Mechanical Equip. Room Leaks | 1260 | 0.88 |
| 8) Heating Equip./SEP Losses (1) | 1034 | 0.72 |
| 9) SEP Start-up Losses (1) | 158 | 0.11 |
| 10) Repaired HTW Piping Leaks (1) | 55 | 0.04 |
| **Subtotal Identified Losses (2)** | **6774** | **4.71** |
| | | |
| Average 1995 Make-up Water Use | 9173 | 6.37 |
| - Total Losses Identified | 6774 | 4.71 |
| | | |
| **Estimated HTW Piping Leaks (3)** | **2399** | **1.66** |

(1) Losses obtained from the HTW make-up data, could not be visually verified during survey.
(2) Some leaks may have been repaired or new leaks may have formed since the survey.
(3) Other leaks include HVAC equipment, hot water generators, equipment repair, etc.

PIE CHART VALUES

| | | | |
|---|---|---|---|
| Blowdown & Soot Blowing | 1908 | 1.33 | 21% |
| CEP/SEP/VP/ME Rm Leaks | 3619 | 2.51 | 39% |
| Other Identified Losses | 1247 | 0.87 | 14% |
| HTW Piping Leaks | 2399 | 1.66 | 26% |
| | | | 100% |

BAR CHART VALUES

| | 1993 | 1994 | 1995 |
|---|---|---|---|
| Blowdown & Soot Blowing | 1908 | 1908 | 1908 |
| Valve & Equip. Leaks | 3619 | 3619 | 3619 |
| Other Losses | 1247 | 1247 | 1247 |
| HTW Piping Leaks | 6072 | 7682 | 2399 |

# Test Procedure

## Objective

To determine the hot water system leaks external to the Steam Plant

## System Description

The hot water heating and distribution system consists of three gas/oil fired package boilers, one stoker fired wood boiler, three (3) cascade water heaters and circulating pumps. Boiler steam is condensed in the cascade heaters warming the water. The hot water is circulated facility wide in an underground distribution system supplying the heat for various needs including domestic hot water heating for kitchen, bathroom and laundry use, steam for cooking. Space heating is also provided during the winter months. Closed heat exchangers at each use point remove heat from the water. The slightly cooled water is returned to the steam plant for re-heating. The hot water distribution and return system is a closed system. With all valves closed any required make-up water would be due to leaks.

The heated water from the cascade heaters is used for boiler feedwater. The known system loses are the result of steam soot blowing (primarily on the wood fired boiler) and boiler blowdown along with scattered steam leaks typical of such a facility.

## Procedure

Fill the system (no. 1 heater ) to the desired level. Note the time and the make-up water totalizer reading. Operate the facility normally for 8 hours, except:

- do not operate the steam soot blowers.
- do not blow down the boilers.
- do not blow down the heaters.
- do not deliberately allow water or steam losses from any source.

Keep the power plant as "tight" as possible. Keep heater water levels within acceptable limits. Near the end of the 8 hour period fill the heaters to the starting level, record the time and the makeup water totalizer reading.

## Results

The amount of make-up water used during the test should be theoretically equal the total system loses during the test. Since the system losses in the steam plant are minimized, the make-up water consumed is equal to system leaks outside the steam plant.

10/95

## Leak Test Results

The results of the enclosed leak test procedure yielded a loss of 1787 gallons in an 8 hour period (223 gal/hr, 3.72 gpm, 5361 gpd). This loss was attributed to hot water distribution system leaks outside of the steam plant. Summing these losses with those from sootblowing and blowdown estimates above yields a daily make-up flow of 6045 gallons (5361+468+216). More importantly, however the losses from sootblowing and boiler blow down are shown to be a small part (11.3%) of the total system losses.

CALCULATE % LOSSES

Fort Stewart – Central Energy Plant
Estimate of HTW System Losses
Filename: F-HTW-CP.WQ1

| Pipe Service | Bldg. Served | Pipe Dia. (in) | Linear Ft w/loops | Pipe Vol. (CF) | Pipe Vol. (Gal) |
|---|---|---|---|---|---|
| ZONE 1 | | | | | |
| HTWS | All (main) | 8 | 1485 | 518.4 | 3880 |
| HTWR | All (main) | 8 | 1485 | 518.4 | 3880 |
| HTWS | All (main) | 8 | 2200 | 767.9 | 5750 |
| HTWR | All (main) | 8 | 2200 | 767.9 | 5750 |
| HTWS | All (main) | 6 | 220 | 43.2 | 320 |
| HTWR | All (main) | 6 | 220 | 43.2 | 320 |
| HTWS | All (main) | 6 | 2035 | 399.6 | 2990 |
| HTWR | All (main) | 6 | 2035 | 399.6 | 2990 |
| HTWS | All (main) | 6 | 825 | 162.0 | 1210 |
| HTWR | All (main) | 6 | 825 | 162.0 | 1210 |
| HTWS | All (main) | 4 | 825 | 72.0 | 540 |
| HTWR | All (main) | 4 | 825 | 72.0 | 540 |
| HTWS | All (main) | 2 | 880 | 19.2 | 140 |
| HTWR | All (main) | 2 | 880 | 19.2 | 140 |
| HTWS | All (main) | 5 | 385 | 52.5 | 390 |
| HTWR | All (main) | 5 | 385 | 52.5 | 390 |
| HTWS | All (main) | 4 | 880 | 76.8 | 570 |
| HTWR | All (main) | 4 | 880 | 76.8 | 570 |
| HTWS | All (main) | 2.5 | 440 | 15.0 | 110 |
| HTWR | All (main) | 2.5 | 440 | 15.0 | 110 |
| Branch Piping (assume 5% of mains) | | | | | 1590 |
| Bldgs | 72 | 1 | 100 | 0.5 | 290 |
| SUBTOTAL ZONE 1 | | | 20350 | | 33680 |
| | | | | | |
| ZONE 2 | | | | | |
| HTWS | All (main) | 6 | 4070 | 799.1 | 5980 |
| HTWR | All (main) | 6 | 4070 | 799.1 | 5980 |
| HTWS | All (main) | 5 | 1375 | 187.5 | 1400 |
| HTWR | All (main) | 5 | 1375 | 187.5 | 1400 |
| HTWS | All (main) | 4 | 550 | 48.0 | 360 |
| HTWR | All (main) | 4 | 550 | 48.0 | 360 |
| HTWS | All (main) | 2 | 4510 | 98.4 | 740 |
| HTWR | All (main) | 2 | 4510 | 98.4 | 740 |
| HTWS | All (main) | 1.5 | 330 | 4.0 | 30 |
| HTWR | All (main) | 1.5 | 330 | 4.0 | 30 |
| HTWS | All (main) | 2.5 | 550 | 18.7 | 140 |
| HTWR | All (main) | 2.5 | 550 | 18.7 | 140 |
| HTWS | All (main) | 2.25 | 990 | 27.3 | 200 |
| HTWR | All (main) | 2.25 | 990 | 27.3 | 200 |
| HTWS | All (main) | 1.25 | 1980 | 16.9 | 130 |
| HTWR | All (main) | 1.25 | 1980 | 16.9 | 130 |
| HTWS | All (main) | 2 | 770 | 16.8 | 130 |
| HTWR | All (main) | 2 | 770 | 16.8 | 130 |
| Branch Piping (assume 5% of mains) | | | | | 910 |
| Bldgs | 34 | 1 | 100 | 0.5 | 140 |
| SUBTOTAL ZONE 2 | | | 30250 | | 19270 |

CALCULATE % LOSSES

Fort Stewart – Central Energy Plant
Estimate of HTW System Losses
Filename: F–HTW–CP.WQ1

| | | | | | |
|---|---|---|---|---|---|
| ZONE 3 | | | | | |
| HTWS | All (main) | 10 | 5225 | 2849.8 | 21320 |
| HTWR | All (main) | 10 | 5225 | 2849.8 | 21320 |
| HTWS | All (main) | 10 | 3850 | 2099.8 | 15710 |
| HTWR | All (main) | 10 | 3850 | 2099.8 | 15710 |
| HTWS | All (main) | 6 | 1980 | 388.8 | 2910 |
| HTWR | All (main) | 6 | 1980 | 388.8 | 2910 |
| HTWS | All (main) | 5 | 990 | 135.0 | 1010 |
| HTWR | All (main) | 5 | 990 | 135.0 | 1010 |
| HTWS | All (main) | 8 | 605 | 211.2 | 1580 |
| HTWR | All (main) | 8 | 605 | 211.2 | 1580 |
| HTWS | All (main) | 6 | 605 | 118.8 | 890 |
| HTWR | All (main) | 6 | 605 | 118.8 | 890 |
| HTWS | All (main) | 4 | 1100 | 96.0 | 720 |
| HTWR | All (main) | 4 | 1100 | 96.0 | 720 |
| HTWS | All (main) | 2 | 880 | 19.2 | 140 |
| HTWR | All (main) | 2 | 880 | 19.2 | 140 |
| HTWS | All (main) | 4 | 1650 | 144.0 | 1080 |
| HTWR | All (main) | 4 | 1650 | 144.0 | 1080 |
| Branch Piping (assume 5% of mains) | | | | | 4540 |
| Bldgs | 27 | 1 | 100 | 0.5 | 110 |
| SUBTOTAL ZONE 3 | | | 33770 | | 95370 |
| | | | | | |
| SEP ZONE | | | | | |
| HTWR | All (main) | 4 | 5390 | 470.4 | 3520 |
| HTWR | All (main) | 2 | 5390 | 117.6 | 880 |
| STMS | All (main) | 10 | 5390 | 2939.8 | 150 |
| HTWS | All (main) | 8 | 440 | 153.6 | 1150 |
| HTWR | All (main) | 8 | 440 | 153.6 | 1150 |
| HTWS | All (main) | 4 | 2860 | 249.6 | 1870 |
| HTWR | All (main) | 4 | 2860 | 249.6 | 1870 |
| HTWS | All (main) | 3 | 880 | 43.2 | 320 |
| HTWR | All (main) | 3 | 880 | 43.2 | 320 |
| HTWS | All (main) | 2.5 | 1760 | 60.0 | 450 |
| HTWR | All (main) | 2.5 | 1760 | 60.0 | 450 |
| HTWS | All (main) | 2 | 770 | 16.8 | 130 |
| HTWR | All (main) | 2 | 770 | 16.8 | 130 |
| HTWS | All (main) | 2 | 990 | 21.6 | 160 |
| HTWR | All (main) | 2 | 990 | 21.6 | 160 |
| Branch Piping (assume 5% of mains) | | | | | 640 |
| Bldgs | 5 | 1 | 100 | 0.5 | 20 |
| SUBTOTAL SEP ZONE | | | 31570 | | 13370 |
| | | | | | |
| Cascade Htrs, Expansion Tanks, etc., estimated | | | | | 14500 |
| | | | | | |
| Total Estimated System Volume | | | | | 176190 Gallons |

CALCULATE % LOSSES

Fort Stewart - Central Energy Plant
Estimate of HTW System Losses
Filename: F-HTW-CP.WQ1

CALCULATION OF PERCENT HTW LOSSES

Typical Closed Loop Piping Systems

| | |
|---|---|
| 0.5% of total volume lost per day = | 881 Gal/Day |
| 881 gal/day x 30.4 day/mo = | 26796 Gal/Mo. |
| 881 gpd / 1440 min/day = | 0.61 Gal/Min |

Fort Stewart HTW Piping System

| | |
|---|---|
| 2203 gal/day x 30.4 day/mo = | 67014 Gal/Mo. |
| 2203 gpd / 1440 min/day = | 1.53 Gal/Min |
| Percent of total volume lost per day = | 1.3% |

**Blowdown**

Blowing down the boiler is required to control the boiler water chemistry. Excessive blowdown is wasteful. Insufficient blowdown can severely damage the boiler pressure parts over time. Generally, the boilers should be blown down as little as possible while keeping the boiler water chemistry under control. The blowdown procedures should be reviewed. Blowing down the lower headers every shift is generally regarded as excessive.

The American Boiler Manufacturers Association recommends that boilers operating below 300 psig should have less than 3500 ppm total solids, less than 700 ppm total Alkalinity, and less than 300 ppm total suspended solids. If the boiler water concentrations of these parameters are substantially below these values, then perhaps the boilers are being blown down too much.

The lower header blowdown valves are 1-1/2" diameter, but are connected to 3/4" diameter pipe from the valves to the blowdown tank. The 3/4" pipe controls the flow from the boiler's lower headers when the blowdown valves are wide open. Assuming an equivalent of 100 feet of pipe from the valves to the blow down tank yields a flow rate of 48 gpm. A ten second blow from each of the three lower headers would actually take 30 seconds each (10 seconds to open the valve , ten seconds to blow, and ten seconds to close the valve) yielding a consumption of 24 gallons per blow. With three lower headers and three blows per day per header, 216 gal. per day are discharged requiring an equivalent amount of make-up.

BOILER & CASCADE HEATER BLOWDOWN

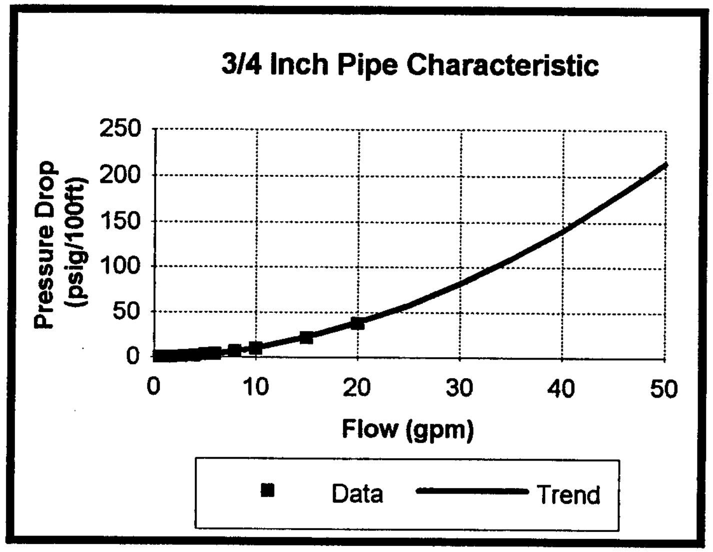
## Table 4.2-1 ESTIMATED WATER LOSS DUE TO BLOWDOWN

| Blowdown Point | Duration Est. (min) Est. #1 | Duration Est. (min) Est. #2 | Pipe Dia. (in) | Pipe Length (ft) | Pres. Drop (ft) | Flow (gpm) | Flow (gpd, #1) | Flow (gpd, #2) | Average (gpd) |
|---|---|---|---|---|---|---|---|---|---|
| **Intermittent (1)** | | | | | | | | | |
| Heater #1 | 0.42 | 0.17 | 1 | 100 | 400 | 87.5 | 36.5 | 14.6 | |
| Level Xmtr. | 0.20 | 0.08 | 1 | 10 | 400 | 320.9 | 64.2 | 26.7 | |
| Heater #2 | 0.42 | 0.17 | 1 | 100 | 400 | 87.5 | 36.5 | 14.6 | |
| Level Xmtr. | 0.20 | 0.08 | 1 | 10 | 400 | 320.9 | 64.2 | 26.7 | |
| Heater #3 | 0.42 | 0.17 | 1 | 100 | 400 | 87.5 | 36.5 | 14.6 | |
| Level Xmtr. | 0.20 | 0.08 | 1 | 10 | 400 | 320.9 | 64.2 | 26.7 | |
| No. 4 Boiler | | | | | | | | | |
| East Wall | 0.33 | 0.50 | 1 | 100 | 400 | 87.5 | 29.2 | 43.8 | |
| West Wall | 0.33 | 0.50 | 1 | 100 | 400 | 87.5 | 29.2 | 43.8 | |
| Rear Wall | 0.33 | 0.50 | 1 | 100 | 400 | 87.5 | 29.2 | 43.8 | |
| East Drum | 0.33 | 0.50 | 1 | 100 | 400 | 87.5 | 29.2 | 43.8 | |
| West Drum | 0.33 | 0.50 | 1 | 100 | 400 | 87.5 | 29.2 | 43.8 | |
| **Sub-total Intermittent Blowdown - Summer** | | | | | | | 448 | 343 | 395 |
| Heater #4 | 0.42 | 0.17 | 1 | 100 | 400 | 87.5 | 36.5 | 14.6 | |
| Level Xmtr. | 0.20 | 0.08 | 1 | 10 | 400 | 320.9 | 64.2 | 26.7 | |
| Heater #5 | 0.42 | 0.17 | 1 | 100 | 400 | 87.5 | 36.5 | 14.6 | |
| Level Xmtr. | 0.20 | 0.08 | 1 | 10 | 400 | 320.9 | 64.2 | 26.7 | |
| **Additional Intermittent Blowdown - Winter** | | | | | | | 201 | 83 | 142 |
| **Continuous (2)** | | | | | | | | | |
| Steam Drum | 1440 | 0 | 1/16 | 100 | 400 | 1.353 | 1948 | 0 | 974 |
| **Total Blowdown - Summer** | | | | | | | 2396 | 343 | 1369 |
| **Total Blowdown - Winter** | | | | | | | 2597 | 425 | 1511 |

(1) Assumes 200 psi, 1 inch orifice, square edged, C=0.82; Cameron Hydraulic Data, pages 2-8 and 2-9.
(2) Assumes 200 psi, 1/16 inch orifice, square edged, C=0.82; Cameron Hydraulic Data, pages 2-8 and 2-9.

BOILER & CASCADE HEATER BLOWDOWN

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1.886 | -2.01536 | 6.59603 | 0.133273 | | | |
| 0.5 | 0.033 | -0.6931 | -3.41 | 0.036 | | | | | | |
| 0.6 | 0.041 | -0.5108 | -3.19 | 0.051 | | | | | | |
| 0.8 | 0.102 | -0.2231 | -2.28 | 0.087 | | | | | | |
| 1 | 0.155 | 0 | -1.86 | 0.133 | | | | | | |
| 2 | 0.526 | 0.69315 | -0.64 | 0.493 | | | | | | |
| 3 | 1.09 | 1.09861 | 0.086 | 1.059 | | | | | | |
| 4 | 1.83 | 1.38629 | 0.604 | 1.822 | | | | | | |
| 5 | 2.75 | 1.60944 | 1.012 | 2.775 | | | | | | |
| 6 | 3.84 | 1.79176 | 1.345 | 3.915 | | | | | | |
| 8 | 6.6 | 2.07944 | 1.887 | 6.736 | | | | | | |
| 10 | 9.99 | 2.30259 | 2.302 | 10.261 | | | | | | |
| 15 | 21.6 | 2.70805 | 3.073 | 22.050 | | | | | | |
| 20 | 37.8 | 2.99573 | 3.632 | 37.940 | | | | | | |
| 25 | 57.7975907 | | | 57.798 | | | | | | |
| 30 | 81.52346277 | | | 81.523 | | | | | | |
| 35 | | | | 109.037 | | | | | | |
| 40 | | | | 140.273 | | | | | | |
| 48.275 | | | | 200.000 | | | | | | |
| 50 | | | | 213.694 | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| FLOW (GPM) | TIME (SEC/SHIFT) | BLOW POINTS | SHIFT /DAY | | GAL/DAY | GPM | | | | |
| 48 | 30 | 3 | 3 | | 216 | 0.150 | | | | |
| LBS/CY | GAL/CY | LOWER | CY/SH | SH/D | | | | | | |
| 325 | 39.0 | 2 | 2 | 3 | 468 | 0.325 | | | | |
| | | | | | | | | | | |
| | | | | | 684 | 0.475 | | | | |
| | | | | | | | | | | |
| 5.63 | 3.72 | | | | | | | | | |
| 5.63 | 4.20 | | | | | | | | | |
| 8100 | 6045 | | | | | | | | | |

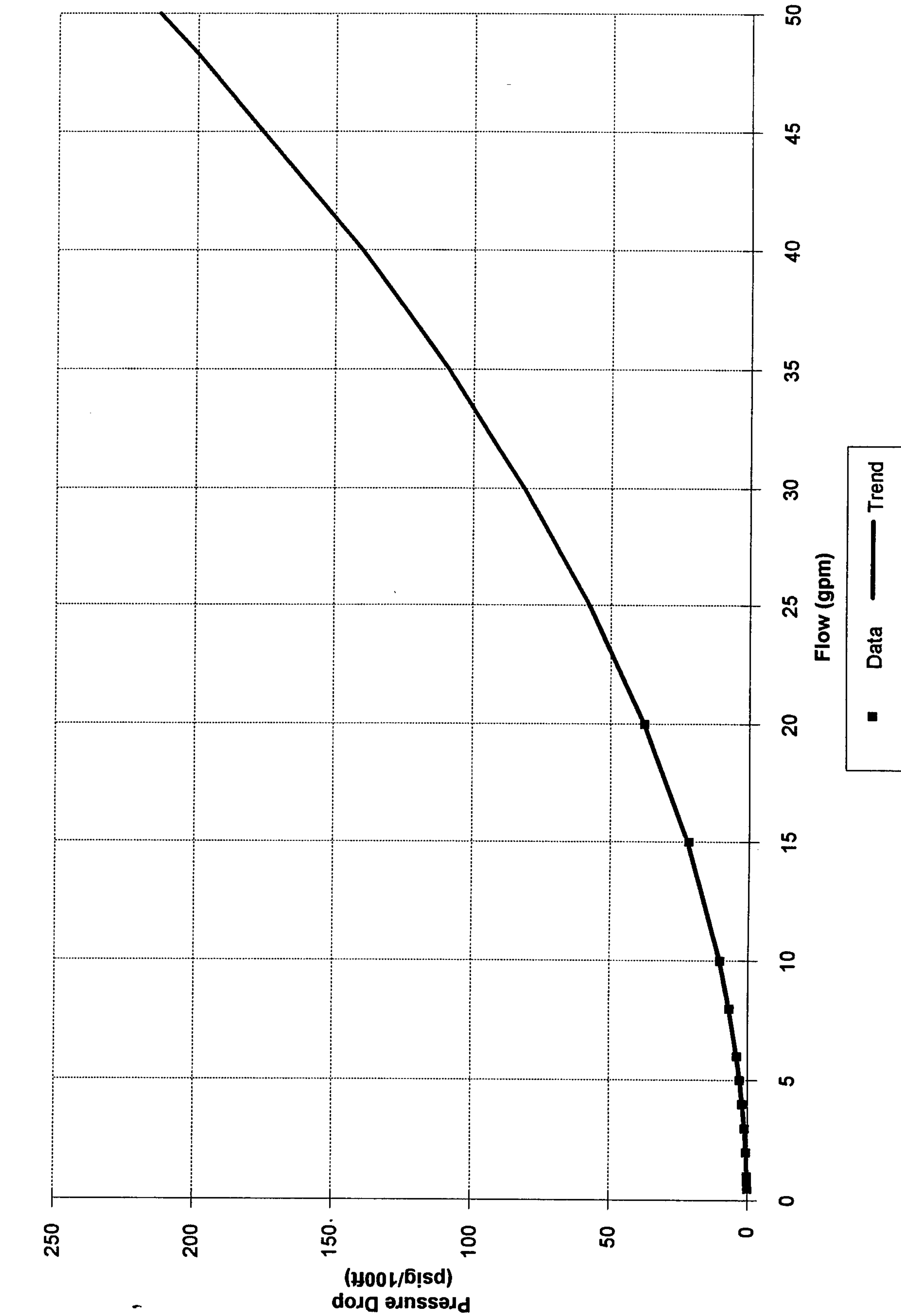


BOILER & CASCADE HEATER BLOWDOWN

10/12/95

**FIGURE 2**

**3/4 Inch Pipe Characteristic**




STEWMU.XLS Chart 11

## FLOW THROUGH ORIFICES AND NOZZLES

Approximate discharge through orifice or nozzle.

$$Q = 19.636\, C d_1^2 \sqrt{h} \sqrt{\frac{1}{1 - \left(\frac{d_1}{d_2}\right)^4}} \text{ where } \frac{d_1}{d_2} \text{ is greater than } 0.3$$

$$Q = 19.636\, C d_1^2 \sqrt{h} \text{ where } \frac{d_1}{d_2} \text{ is less than } 0.3$$

$Q$ = flow, in gpm
$d_1$ = dia of orifice or nozzle opening, inches
$h$ = differential head at orifice, in feet of liquid.
$d_2$ = dia of pipe in which orifice is placed, inches
$C$ = discharge coefficient (typical values below for water)

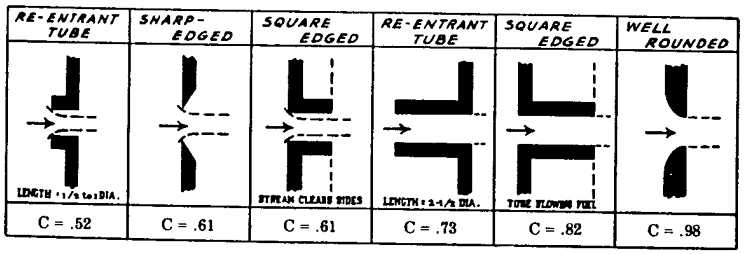



Table on next page shows flow using a value of C = 1.00. These flows values may be multiplied by the C value for a particular discharge to obtain actual flow.

Approximate flow through Venturi tube.

$$Q = 19.05\, d_1^2 \sqrt{H} \sqrt{\frac{1}{1 - \left(\frac{d_1}{d_2}\right)^4}} \text{ for any Venturi tube}$$

$$Q = 19.17\, d_1^2 \sqrt{H} \text{ for a Venturi tube in which } d_1 = 1/3\, d_2$$

$Q$ = flow, in gpm
$d_1$ = dia. of venturi throat, inches
$d_2$ = dia. of main pipe, inches
$H$ = diff. in head between upstream end and throat (ft.)

These formulas are suitable for any liquid with viscosities similar to water. The values given here are for water. A value of 32.174 ft. per sec² was used for the acceleration of gravity and a value of 7.48 gal. per cu ft in computing the constants.



A.4-11



2

BOILER & CASCADE HEATER BLOWDOWN

## Flow Data—Nozzles

### Theoretical Discharge of Nozzles in U S Gallons Per Minute

| Head* psi | Head* feet** | Velocity of disch ft/sec | 1/16 | 1/8 | 3/16 | 1/4 | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1 1/8 | 1 1/4 | 1 3/8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 23.1 | 38.6 | 0.37 | 1.48 | 3.32 | 5.91 | 13.3 | 23.6 | 36.9 | 53.1 | 72.4 | 94.5 | 120 | 148 | 179 |
| 15 | 34.6 | 47.25 | 0.45 | 1.81 | 4.06 | 7.24 | 16.3 | 28.9 | 45.2 | 65.0 | 88.5 | 116. | 147 | 181 | 219 |
| 20 | 46.2 | 54.55 | 0.52 | 2.09 | 4.69 | 8.35 | 18.8 | 33.4 | 52.2 | 75.1 | 102. | 134. | 169 | 209 | 253 |
| 25 | 57.7 | 61.0 | 0.58 | 2.34 | 5.25 | 9.34 | 21.0 | 37.3 | 58.3 | 84.0 | 114. | 149. | 189 | 234 | 283 |
| 30 | 69.3 | 66.85 | 0.64 | 2.56 | 5.75 | 10.2 | 23.0 | 40.9 | 63.9 | 92.0 | 125. | 164. | 207 | 256 | 309 |
| 35 | 80.8 | 72.2 | 0.69 | 2.77 | 6.21 | 11.1 | 24.8 | 44.2 | 69.0 | 99.5 | 135. | 177. | 224 | 277 | 334 |
| 40 | 92.4 | 77.2 | 0.74 | 2.96 | 6.64 | 11.8 | 26.6 | 47.3 | 73.8 | 106. | 145. | 188. | 239 | 296 | 357 |
| 45 | 103.9 | 81.8 | 0.78 | 3.13 | 7.03 | 12.5 | 28.2 | 50.1 | 78.2 | 113. | 153. | 200. | 253 | 313 | 379 |
| 50 | 115.5 | 86.25 | 0.83 | 3.30 | 7.41 | 13.2 | 29.7 | 52.8 | 82.5 | 119. | 162. | 211. | 267 | 330 | 399 |
| 55 | 127.0 | 90.5 | 0.87 | 3.46 | 7.77 | 13.8 | 31.1 | 55.3 | 86.4 | 125. | 169. | 221. | 280 | 346 | 418 |
| 60 | 138.6 | 94.5 | 0.90 | 3.62 | 8.12 | 14.5 | 32.5 | 57.8 | 90.4 | 130. | 177. | 231. | 293 | 362 | 438 |
| 65 | 150.1 | 98.3 | 0.94 | 3.77 | 8.45 | 15.1 | 33.8 | 60.2 | 94.0 | 136. | 184. | 241. | 305 | 376 | 455 |
| 70 | 161.7 | 102.1 | 0.98 | 3.91 | 8.78 | 15.7 | 35.2 | 62.5 | 97.7 | 141. | 191. | 250. | 317 | 391 | 473 |
| 75 | 173.2 | 105.7 | 1.01 | 4.05 | 9.08 | 16.2 | 36.4 | 64.7 | 101. | 146. | 198. | 259. | 327 | 404 | 489 |
| 80 | 184.8 | 109.1 | 1.05 | 4.18 | 9.39 | 16.7 | 37.6 | 66.8 | 104. | 150. | 205. | 267. | 338 | 418 | 505 |
| 85 | 196.3 | 112.5 | 1.08 | 4.31 | 9.67 | 17.3 | 38.8 | 68.9 | 108. | 155. | 211. | 276. | 349 | 431 | 521 |
| 90 | 207.9 | 115.8 | 1.11 | 4.43 | 9.95 | 17.7 | 39.9 | 70.8 | 111. | 160. | 217. | 284. | 359 | 443 | 536 |
| 95 | 219.4 | 119.0 | 1.14 | 4.56 | 10.2 | 18.2 | 41.0 | 72.8 | 114. | 164. | 223. | 292. | 369 | 456 | 551 |
| 100 | 230.9 | 122.0 | 1.17 | 4.67 | 10.5 | 18.2 | 42.1 | 74.7 | 117. | 168. | 229. | 299. | 378 | 467 | 565 |
| 105 | 242.4 | 125.0 | 1.20 | 4.79 | 10.8 | 19.2 | 43.1 | 76.5 | 120. | 172. | 234. | 306. | 388 | 479 | 579 |
| 110 | 254.0 | 128.0 | 1.23 | 4.90 | 11.0 | 19.6 | 44.1 | 78.4 | 122. | 176. | 240. | 314. | 397 | 490 | 593 |
| 115 | 265.5 | 130.9 | 1.25 | 5.01 | 11.2 | 20.0 | 45.1 | 80.1 | 125. | 180. | 245. | 320. | 406 | 501 | 606 |
| 120 | 277.1 | 133.7 | 1.28 | 5.12 | 11.5 | 20.5 | 46.0 | 81.8 | 128. | 184. | 251. | 327. | 414 | 512 | 619 |
| 130 | 300.2 | 139.1 | 1.33 | 5.33 | 12.0 | 21.3 | 48.0 | 85.2 | 133. | 192. | 261. | 341. | 432 | 533 | 645 |
| 140 | 323.3 | 144.3 | 1.38 | 5.53 | 12.4 | 22.1 | 49.8 | 88.4 | 138. | 199. | 271. | 354. | 448 | 553 | 668 |
| 150 | 346.4 | 149.5 | 1.43 | 5.72 | 12.9 | 22.9 | 51.6 | 91.5 | 143. | 206. | 280. | 366. | 463 | 572 | 692 |
| 175 | 404.1 | 161.4 | 1.55 | 6.18 | 13.9 | 24.7 | 55.6 | 98.8 | 154. | 222. | 302. | 395. | 500 | 618 | 747 |
| 200 | 461.9 | 172.6 | 1.65 | 6.61 | 14.8 | 26.4 | 59.5 | 106. | 165. | 238. | 323. | 423. | 535 | 660 | 799 |
| 250 | 577.4 | 193.0 | 1.85 | 7.39 | 16.6 | 29.6 | 66.5 | 118. | 185. | 266. | 362. | 473. | 598 | 739 | 894 |
| 300 | 692.8 | 211.2 | 2.02 | 8.08 | 18.2 | 32.4 | 72.8 | 129. | 202. | 291. | 396. | 517. | 655 | 808 | 977 |

| Head* psi | Head* feet** | Velocity of disch ft/sec | 1 1/2 | 1 3/4 | 2 | 2 1/4 | 2 1/2 | 2 3/4 | 3 | 3 1/2 | 4 | 4 1/2 | 5 | 5 1/2 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 23.1 | 38.6 | 213 | 289 | 378 | 479 | 591 | 714 | 851 | 1158 | 1510 | 1915 | 2365 | 2855 | 3405 |
| 15 | 34.6 | 47.25 | 260 | 354 | 463 | 585 | 723 | 874 | 1041 | 1418 | 1850 | 2345 | 2890 | 3490 | 4165 |
| 20 | 46.2 | 54.55 | 301 | 409 | 535 | 676 | 835 | 1009 | 1203 | 1638 | 2135 | 2710 | 3340 | 4040 | 4810 |
| 25 | 57.7 | 61.0 | 336 | 458 | 598 | 756 | 934 | 1128 | 1345 | 1830 | 2385 | 3025 | 3730 | 4510 | 5380 |
| 30 | 69.3 | 66.85 | 368 | 501 | 655 | 828 | 1023 | 1236 | 1473 | 2005 | 2615 | 3315 | 4090 | 4940 | 5895 |
| 35 | 80.8 | 72.2 | 398 | 541 | 708 | 895 | 1106 | 1335 | 1591 | 2168 | 2825 | 3580 | 4415 | 5340 | 6370 |
| 40 | 92.4 | 77.2 | 425 | 578 | 756 | 957 | 1182 | 1428 | 1701 | 2315 | 3020 | 3830 | 4725 | 5610 | 6810 |
| 45 | 103.9 | 81.8 | 451 | 613 | 801 | 1015 | 1252 | 1512 | 1802 | 2455 | 3200 | 4055 | 5000 | 6050 | 7120 |
| 50 | 115.5 | 86.25 | 475 | 647 | 845 | 1070 | 1320 | 1595 | 1900 | 2590 | 3375 | 4275 | 5280 | 6380 | 7600 |
| 55 | 127.0 | 90.4 | 498 | 678 | 886 | 1121 | 1385 | 1671 | 1991 | 2710 | 3540 | 4480 | 5530 | 6690 | 7970 |
| 60 | 138.6 | 94.5 | 521 | 708 | 926 | 1172 | 1447 | 1748 | 2085 | 2835 | 3700 | 4685 | 5790 | 6980 | 8330 |
| 65 | 150.1 | 98.3 | 542 | 737 | 964 | 1220 | 1506 | 1819 | 2165 | 2950 | 3850 | 4875 | 6020 | 7270 | 8670 |
| 70 | 161.7 | 102.1 | 563 | 765 | 1001 | 1267 | 1565 | 1888 | 2250 | 3065 | 4000 | 5060 | 6250 | 7560 | 9000 |
| 75 | 173.2 | 105.7 | 582 | 792 | 1037 | 1310 | 1619 | 1955 | 2330 | 3170 | 4135 | 5240 | 6475 | 7820 | 9320 |
| 80 | 184.8 | 109.1 | 602 | 818 | 1070 | 1354 | 1672 | 2020 | 2405 | 3280 | 4270 | 5410 | 6690 | 8080 | 9630 |
| 85 | 196.3 | 112.5 | 620 | 844 | 1103 | 1395 | 1723 | 2080 | 2480 | 3375 | 4400 | 5575 | 6890 | 8320 | 9920 |
| 90 | 207.9 | 115.8 | 638 | 868 | 1136 | 1436 | 1773 | 2140 | 2550 | 3475 | 4530 | 5740 | 7090 | 8560 | 10210 |
| 95 | 219.4 | 119.0 | 656 | 892 | 1168 | 1476 | 1824 | 2200 | 2625 | 3570 | 4655 | 5900 | 7290 | 8800 | 10500 |
| 100 | 230.9 | 122.0 | 672 | 915 | 1196 | 1512 | 1870 | 2255 | 2690 | 3660 | 4775 | 6050 | 7470 | 9030 | 10770 |
| 105 | 242.4 | 125.0 | 689 | 937 | 1226 | 1550 | 1916 | 2312 | 2755 | 3750 | 4890 | 6200 | 7650 | 9260 | 11020 |
| 110 | 254.0 | 128.0 | 705 | 960 | 1255 | 1588 | 1961 | 2366 | 2820 | 3840 | 5010 | 6340 | 7840 | 9470 | 11300 |
| 115 | 265.5 | 130.9 | 720 | 980 | 1282 | 1621 | 2005 | 2420 | 2885 | 3930 | 5120 | 6490 | 8010 | 9680 | 11550 |
| 120 | 277.1 | 133.7 | 736 | 1002 | 1310 | 1659 | 2050 | 2470 | 2945 | 4015 | 5225 | 6630 | 8180 | 9900 | 11800 |
| 130 | 300.2 | 139.1 | 767 | 1043 | 1365 | 1726 | 2132 | 2575 | 3070 | 4175 | 5450 | 6900 | 8530 | 10300 | 12290 |
| 140 | 323.3 | 144.3 | 795 | 1082 | 1415 | 1790 | 2212 | 2650 | 3180 | 4330 | 5650 | 7160 | 8850 | 10690 | 12730 |
| 150 | 346.4 | 149.5 | 824 | 1120 | 1466 | 1853 | 2290 | 2760 | 3295 | 4485 | 5850 | 7410 | 9150 | 11070 | 13200 |
| 175 | 404.1 | 161.4 | 890 | 1210 | 1582 | 2000 | 2473 | 2985 | 3560 | 4840 | 6310 | 8000 | 9890 | 11940 | 14250 |
| 200 | 461.9 | 172.6 | 950 | 1294 | 1691 | 2140 | 2645 | 3190 | 3800 | 5175 | 6760 | 8550 | 10580 | 12770 | 15220 |
| 250 | 577.4 | 193.0 | 1063 | 1447 | 1891 | 2392 | 2955 | 3570 | 4250 | 5795 | 7550 | 9570 | 11820 | 14290 | 17020 |
| 300 | 692.8 | 211.2 | 1163 | 1582 | 2070 | 2615 | 3235 | 3900 | 4650 | 6330 | 8260 | 10480 | 12940 | 15620 | 18610 |

The actual quantity discharged by a nozzle will be less than above table. A well tapered smooth nozzle may be assumed to give 97 to 99% of the values in the tables.

* Where there is both an upstream and downstream pressure, the head is a differential head.

** Head in feet basis water at approx. 60°F.

SOOTBLOWING LOSSES

## Sootblowing

The sootblowing operations should be carefully reviewed. Blowing soot twice per shift regardless of need is not proper procedure. Blowing too frequently can cause excessive tube erosion perhaps resulting in premature tube replacement. Frequent blowing is also wasteful of valuable steam, particularly at reduced boiler loads.

Soot blowing should be initiated primarily by high exit gas temperature which indicates that the energy released by the fuel is not being absorbed by the dirty tube surfaces. A 40° rise in exit gas temperature is approximately equal to 1% in boiler efficiency. Often this rule of thumb is used to determine when the boiler has become fouled with the solid products of combustion and should be cleaned by operating the sootblowers. Unfortunately, there is no indication of exit gas temperature on the boiler.

A simple thermometer ($50) can be installed in the hot gas duct to the air heater to indicate the exit gas temperature. Operators can record the exit gas temperature hourly and activate the soot blowers when the exit gas temperature gets too high.

The Diamond Power factory calculates that 325 lb. steam (39 gals water) are consumed every time the IK sootblower is operated. With two IK blowers and 6 operations each per day the total steam consumption is 3900 lb. steam (468 gals) per day.

| | | | |
|---|---|---|---|
| RS&H | SUBJECT FORT STEWART | AEP NO 694 1331 002 | |
| | CEP Misc. Leaks | SHEET 1 | OF 2 |
| | DESIGNER W. Todd | DATE 2-2-96 | |
| | CHECKER | DATE | |

# CEP MISCELLANEOUS LEAKS

Valves & Fittings:

| | Leak Rate Estimate |
|---|---|
| **Cascade Heater No. 1** | |
| - Valve to top of sight glass leaking steam | 2 drop/sec |
| - Valve on top left of heater leaking steam | 2 " |
| **Cascade Heater No. 2** | |
| - Valve on bottom left of heater leaking steam | 2 " |
| **Cascade Heater No. 3** | |
| - Valve on top of sight glass leaking steam | 2 " |
| **Deaerator Tank** | |
| - Strainer next to control valve leaking steam and about 3 drops/second HTW. | 5 " |
| - Valve above stairs leaking steam | 2 " |
| - Vent to outside blowing steam (intermittant) | 2 " |
| Total valves & fittings leaks | 17 drops/sec |

$$17 \text{ drops/second} \times 2.5\times10^{-3} \frac{\text{gpm}}{\text{d/s}} = \underline{0.042 \text{ gal/min}}$$

HTW Zone Pumps:

- P-4 & P-5 ~ 1 drop / 4 seconds = 0.0006 GPM
- P-10 ~ Steady 1/8" stream * = 0.109 GPM
- P-11 ~ Intermittant 1/8" stream* = 0.054 GPM

RS&H

| | |
|---|---|
| SUBJECT Fort Stewart CEP Misc. Leaks | AEP NO 694 1331 002 |
| DESIGNER W. Todd | SHEET 2 OF 2 |
| CHECKER | DATE 2-2-96 |
| | DATE |

Pumps (continued)

- P-23 & P-24 ~ 2 drops/3 seconds = 0.0017 GPM

*A 1/8" stream was measured and timed and found to be ~1.75 cups/min ÷ 16 $\frac{cups}{gal}$ ≈ 0.109 GPM

Total leaks from HTW Pumps = 0.165 GPM

Total Miscellaneous CEP Leaks:

| | |
|---|---|
| Valves & Fittings | 0.042 GPM |
| HTW Zone Pumps | 0.165 GPM |
| Total = | 0.207 GPM |

CEP - No. 4 HTW LEAKS

**Central Energy Plant (CEP) Leak Test** #4 Boiler

On November 30, 1995 a leak test was conducted at CEP to determine the extent of the leaks associated with Boiler No.4. A significant amount of steam continually vents from the No.4 blowdown tank. To quantify this loss, a CEP leak test would be conducted with the No.4 boiler configured in as a "tight" a mode as possible, and then a second test would be conducted with No.4 in a "normal" (leaky) configuration. The difference in the test results would be the leaks due to No. 4's normal configuration.

The leak test consists of measuring the make-up water required to maintain constant heater levels over an 8 hour period. Unfortunately, the test results showed no heater level changes over the 6 hour test period when a 6-7 inch change in the gauge glass level was expected. This testing technique has yielded results in the past. No explanation for the lack of results was determined; however, improper system valving is strongly suspected.

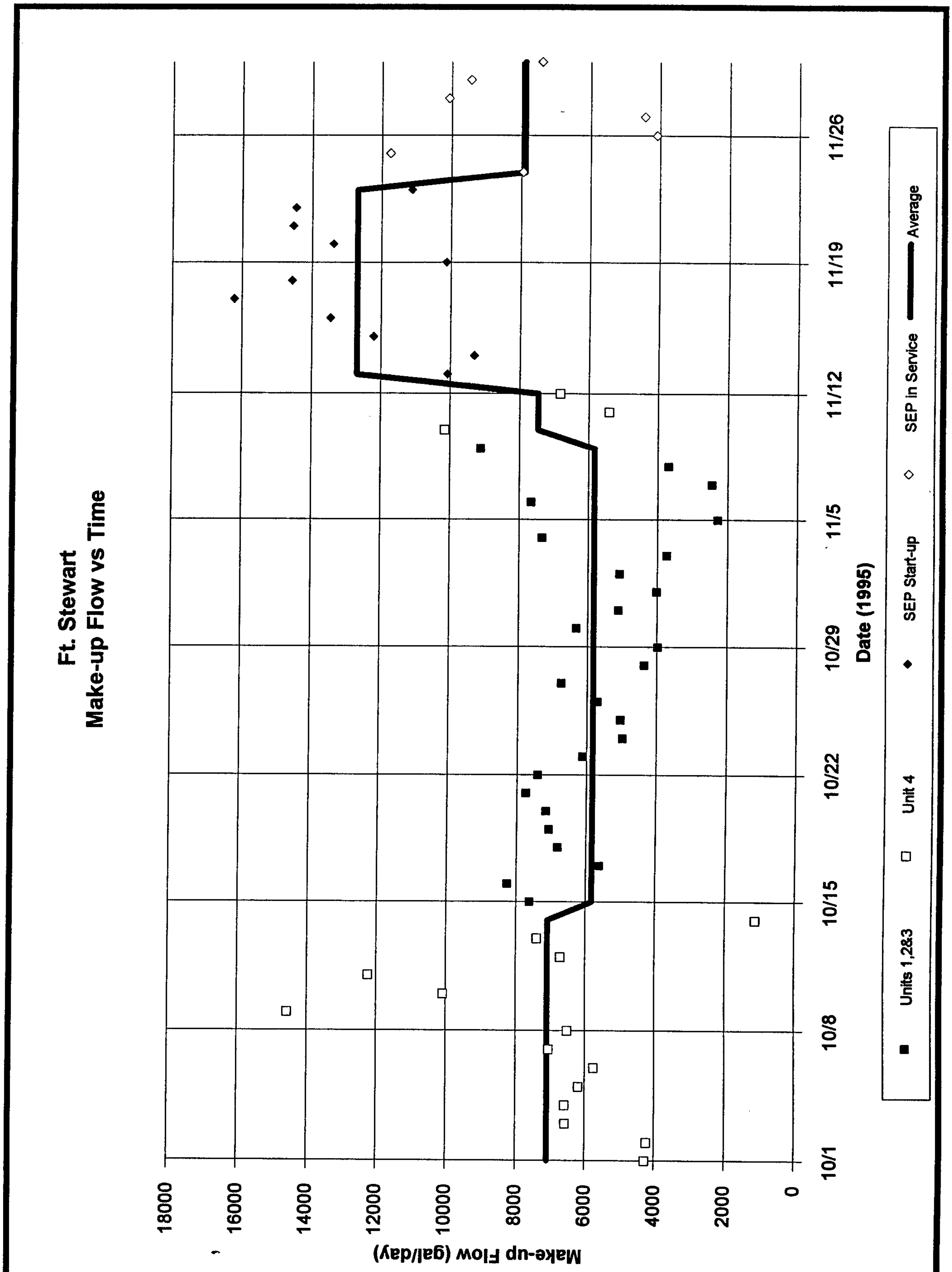
Configuring the boiler in as tight a configuration as possible stopped the blowdown tank steam venting. Leaking steam traps in the main steam line, the soot blower warm-up line, and in the boiler feed pump turbine line are the sources of the steam venting. Furthermore, the rear water wall header blowdown valves are leaking slightly. This leak was so small that only warm water entered the blow down tank.

A graph (enclosed) of the daily make-up consumption data shows a wide scattering of data, perhaps lending credence to the suspicion that observing heater tank levels over a short period of time (8 hours) yields uncertain results. However, when averaged over longer periods of time (weeks), yields more reliable results. The graph shows the daily make-up consumption (DMC) prior to October 15, 1995 averaged about 7000 gpd (4.86 gpm) while unit 4 alone was operating. During the period October 15 through November 10, 1995 unit 4 was shut down and units 1,2 and 3 were operating, and the DMC fell to 5900 gpd (4.10 gpm). This reduction in DMC can be attributed to two principal causes; 1) the general leaky state of unit No. 4; and 2) the required consumption of steam for sootblowing. The magnitude of the change 1100 gpd (0.764 gpm) seems reasonable. The fact that the consumption returned to the original levels when 4 boiler was returned to service implies that some of the leaks are in fact related to unit No. 4.

**No. 4 Boiler Operation Recommendations**

1. Repair steam trap leaks.
2. Reduce soot blowing frequency. Change from a time based operation to an exit gas temperature based operation.
3. Reduce blow down frequency to maintain American Boiler Manufacturers Association standard of 3500 ppm total dissolved solids.

CEP - No. 4 HTW LEAKS



Satellite Energy Plant (SEP) Leak test.

On November 29, 1995 the SEP was tested for system leaks. The testing procedure consists of stopping all steam flow to, and condensate return flow from, the SEP, and measuring the decrease in the level of the two cascade heaters in the SEP. By calculating the volume change in the heaters, a leak rate may be determined.

| | | | | | |
|---|---|---|---|---|---|
| Time (EST) | 9:46 | 10:34 | 11:13 | 11:37 | 11:48 |
| Level (in) | 14.3 | 14.3 | 14.3 | 14.3 | 14.3 |
| Temp (°F) | 375 | 360 | 340 | 335 | 330 |
| Pres. (psig) | 190 | 140 | 115 | 105 | 100 |

The data from the 2 hour test indicated that the water level in the heaters never changed while the circulating hot water showed a -45° temperature change and a -90 psig pressure change. It was concluded therefore the SEP system was "tight".

It is important to note however that the testing method used is quite crude over the short time period of the test. The two, 4000 gallon, cascade heaters are connected by symmetrical piping assuring "equal" water levels in both heaters. A one inch change in water level, at normal operating level, would be equivalent to 140 gallons of water. The leaks found and measured during the test are tabulated below.

| Location | Amount (gpm) |
|---|---|
| East Heater gauge glass | $2.23 \times 10^{-4}$ |
| East Heater Steam Stop valve | $2.11 \times 10^{-3}$ |
| West Heater Equalization valve | $1.00 \times 10^{-3}$ |
| HTWS Check Valve | 0.03 |
| Both Heaters blow down valves | 0.2 |
| **TOTAL** | **0.233** |

The total amount of water lost during the test is 0.233 gpm x 122 min. = 29 gals., or approximately 0.2 inches on the gauge glass. With normal, slow, level swings (generally attributable to sloshing) between the tanks, this leak rate is barley detectable in the sight glass over the time span of the test. Because of the large heater storage capacity, a longer test period is warranted. In the future this test could be a reasonable leak detection and quantification method at the SEP if conducted over longer testing periods. The best time for the test would be when the heat load from the SEP is minimal, perhaps on a warm day after a cool night.

# VALVE PIT HTW LEAKS

**R&H**

SUBJECT Fort Stewart
Repair Leaks in Valve Pits
DESIGNER W. Todd
CHECKER

AEP NO 694 1331 002
SHEET ____ OF ____
DATE 2-5-96
DATE

| Valve Pit No. | Drops /Sec | Stream Dia./GPM | | Leak From |
|---|---|---|---|---|
| VP-1-11 | 1/3 | – | – | Valve |
| VP-1-16 | 3+2 | – | – | |
| VP-2N-5 | 5+ | – | – | |
| VP-2S-1 | 2 | – | – | |
| VP-2S-3 | 2 | – | – | |
| VP-2S-8 | 2+2 | – | – | 2 valves |
| VP-3-1 | 2 | 1/4" | 0.438 | Flange |
| VP-3-5 | 1/10+2 | – | – | Valve |
| VP-3-11 | – | 1/8" | 0.109 | " |
| VP-3-15 | – | 1/8" | 0.109 | Flange |
| VP-3-16 | – | 3/16" | 0.246 | |
| VP-3-18 | 2 | – | – | |
| VP-3-27 | 1+2 | – | – | |
| Totals 13 Pits | 27.4 D/s | 0.902 GPM | | |

Minor Leaks :

$$27.4 \text{ drop/s} \times 2.5\times10^{-3} \frac{\text{GPM}}{\text{d/s}} = 0{,}069 \text{ GPM} = 36{,}270 \frac{\text{GAL}}{\text{YR}}$$

Proposed HTW losses : Assume 50% of minor leaks

$$0.069 \text{ GPM} \times 1440 \frac{\text{min}}{\text{day}} \times 365 \frac{\text{day}}{\text{YR}} \times 0.5 = \underline{18130 \frac{\text{GAL}}{\text{YR}}}$$

Major Leaks : (Assume 100% can be repaired)

$$0.902 \text{ GPM} \times 1440 \text{ min/day} \times 365 \text{ day/YR} = 474{,}090 \text{ GAL/YR}$$

Current HTW Losses :

$$474090 \text{ GAL/YR} + 36270 \text{ GAL/YR} = \underline{510{,}360 \text{ GAL/YR}}$$

# MECH. EQUIP. ROOM HTW LEAKS

Fort Stewart - HTW Distribution System

Filename: FS-BLDGS.WB2

| Building No. | HTW Zone | Building Type | DHW Temp. | Water Sample | Mech Rm Survey | HTW Leaks | Other Leaks | HTW Drop/Sec | HTW Cup/Min | |
|---|---|---|---|---|---|---|---|---|---|---|
| 206 | 3 | Learning Center | 80 | DHW | Y | Y | Y | 2.00 | 0.33 | |
| 207 | 3 | Dining Facility | 124 | DHW | Y | N | N | | | |
| 208 | 3 | Fitness Center | 113 | DHW | Y | Y | N | 0.06 | | |
| 211 | 3 | Admin. | N/A | N/A | Y | Y | N | 4.00 | | |
| 212 | 3 | Admin/Barracks | 131 | DHW | Y | N | N | | | |
| 213 | 3 | Barracks | 120 | DHW | Y | N | N | | | |
| 215 | 3 | Barracks | 137 | DHW | Y | Y | N | 2.00 | 1.50 | F |
| 216 | 3 | Barracks | 110 | DHW | Y | Y | N | 2.50 | | |
| 217 | 3 | Admin. | N/A | N/A | Y | Y | N | 0.13 | | |
| 218 | 3 | Barracks | 124 | DHW | Y | N | Y | | | |
| 223 | 3 | Admin. | N/A | N/A | Y | Y | N | 0.17 | | |
| 224 | 3 | Admin. | N/A | N/A | Y | Y | N | 5.00 | 6.67 | F |
| 225 | 3 | Admin. | N/A | N/A | Y | N | N | | | |
| 230 | 3 | Tac Equip Shop | N/A | N/A | Y | N | N | | | |
| 241 | 3 | Tac Equip Shop | N/A | N/A | Y | N | N | | | |
| 260 | 3 | Tac Equip Shop | N/A | N/A | Y | N | N | | | |
| 270 | 3 | Tac Equip Shop | N/A | N/A | Y | Y | N | 2.20 | | V |
| 276 | 3 | Tac Equip Shop | N/A | N/A | N | | | | | |
| 302 | 3 | Hospital | 137 | DHW | Y | N | N | | | |
| 403 | N/A | Child Care Ctr | N/A | N/A | Y | N/A | N | | | |
| 439 | N/A | Fitness Center | 139 | DHW | Y | N/A | N | | | |
| 440 | 2 | Dental Clinic | 114 | DHW | Y | N | N | | | |
| 501 | 2 | Barracks | 134 | DHW | Y | Y | N | 0.33 | | V |
| 503 | 2 | Barracks | 122 | DHW | Y | Y | N | 2.00 | 0.25 | 2 |
| 504 | 2 | Barracks | 158 | DHW | Y | Y | N | | 0.75 | F |
| 506 | 2 | Admin. | N/A | N/A | Y | N | N | | | |
| 507 | 2 | Admin. | N/A | N/A | Y | Y | N | 1.00 | | V |
| 508 | 2 | Admin. | N/A | N/A | Y | N | N | | | |
| 509 | 2 | Admin. | N/A | N/A | Y | N | Y | | | |
| 512 | 2 | Dining Facility | 145 | DHW | Y | ? | Y | | 1.17 | F |
| 514 | 2 | Barracks | 126 | DHW | Y | Y | N | 1.25 | | F |
| 515 | 2 | Barracks | 123 | DHW | Y | N | Y | | | |
| 516 | 2 | Barracks | 145 | DHW | Y | ? | Y | | | |
| 517 | 2 | Barracks | 175 | DHW | LOCKED | | | | | |
| 518 | 2 | Barracks | 183 | DHW | Y | ? | Y | 3.33 | | F |
| 520 | 2 | Admin. | N/A | N/A | Y | N | Y | | | |
| 521 | 2 | Admin. | N/A | N/A | Y | Y | N | 0.50 | | V |
| 522 | 2 | Admin. | N/A | N/A | Y | Y | N | 0.25 | | V |
| 523 | 2 | Admin. | N/A | N/A | Y | N | N | | | |
| 524 | 2 | Admin. | N/A | N/A | Y | N | N | | | |
| 525 | 2 | Admin. | N/A | N/A | Y | Y | N | 0.09 | | V |

10 Flanges
10 Valves

MECH. ROOM HTW LEAKS

Fort Stewart - HTW Distribution System

Filename: FS-BLDGS.WB2

| Building No. | HTW Zone | Building Type | DHW Temp. | Water Sample | Mech Rm Survey | HTW Leaks | Other Leaks | HTW Drop/Sec | HTW Cup/Min | |
|---|---|---|---|---|---|---|---|---|---|---|
| 608 | 2 | Fitness Center | 127 | DHW | Y | Y | N | 0.08 | | |
| 610 | 2 | Chapel | 115 | DHW | Y | N | N | | | |
| 612 | 2 | Admin. | N/A | N/A | Y | Y | Y | 0.08 | | V |
| 614 | 1 | Admin. | N/A | N/A | Y | N | Y | | | |
| 616 | 1 | Admin. | N/A | N/A | Y | N | Y | | | |
| 617 | 1 | Admin. | N/A | N/A | Y | N | N | | | |
| 618 | 1 | Admin. | N/A | N/A | Y | N | N | | | |
| 619 | 1 | Admin. | N/A | N/A | Y | N | N | | | |
| 620 | 1 | Admin. | 112 | DHW | Y | N | N | | | |
| 621 | 1 | Admin. | 91 | DHW | Y | N | N | | | |
| 622 | 1 | Admin. | 85 | DHW | Y | N | N | | | |
| 623 | 1 | Admin. | 109 | DHW | Y | N | Y | | | |
| 624 | 1 | Admin. | 109 | DHW | Y | N | Y | | | |
| 626 | 1 | Dining Facility | 145 | DHW | Y | N | N | | | |
| 628 | 1 | Admin. | N/A | N/A | Y | Y | N | 0.20 | | V |
| 629 | 1 | Barracks | 160 | DHW | Y | ? | Y | | | |
| 630 | 1 | Barracks | 117 | DHW | Y | N | Y | | | |
| 631 | 1 | Barracks | 142 | DHW | Y | Y | Y | | 0.88 | V+ |
| 632 | 1 | Barracks | 160 | DHW | Y | N | Y | | | |
| 633 | 1 | Barracks | 128 | DHW | Y | Y | Y | 2.00 | | F |
| 634 | 1 | Barracks | LOCKED | LOCKED | Y | N | N | | | |
| 635 | 1 | Barracks | 140 | DHW | Y | Y | N | 1.59 | | F |
| 636 | 1 | Barracks | 138 | DHW | Y | Y | Y | 1.22 | | V |
| 637 | 1 | Barracks | 158 | DHW | Y | N | N | | | |
| 638 | 1 | Admin. | N/A | N/A | Y | N | Y | | | |
| 639 | 1 | Admin. | N/A | N/A | Y | Y | N | 1.56 | | V |
| 640 | 1 | Admin. | N/A | N/A | Y | N | N | | | |
| 641 | 1 | Admin. | N/A | N/A | Y | N | N | | | |
| 642 | 1 | Dining Facility | 154 | DHW | Y | N | Y | | | |
| 643 | 1 | Admin. | N/A | N/A | Y | Y | N | 0.10 | | V |
| 644 | 1 | Admin. | N/A | N/A | Y | Y | N | 0.33 | | V |
| 645 | 1 | Admin. | N/A | N/A | Y | N | N | | | |
| 646 | 1 | Admin. | N/A | N/A | Y | N | N | | | |
| 647 | 1 | Admin. | N/A | N/A | Y | Y | N | 0.20 | | V |
| 648 | 1 | Admin. | N/A | N/A | Y | N | Y | | | |
| 649 | 1 | Admin. | N/A | N/A | Y | N | N | | | |

3 Flanges
9 Valves

MECH. ROOM HTW LEAKS

Fort Stewart - HTW Distribution System

Filename: FS-BLDGS.WB2

| Building No. | HTW Zone | Building Type | DHW Temp. | Water Sample | Mech Rm Survey | HTW Leaks | Other Leaks | HTW Drop/Sec | HTW Cup/Min |
|---|---|---|---|---|---|---|---|---|---|
| 701 | 1 | Health Clinic | 152 | DHW | Y | Y | N | 1.00 | ✓ |
| 702 | 1 | Ent. Center | 143 | DHW | Y | N | N | | |
| 703 | 1 | Enl. Mens Club | N/A | N/A | LOCKED | | Y | | |
| 704 | 1 | Theater | N/A | N/A | Y | N | Y | | |
| 706 | 1 | Branch Exchange | N/A | N/A | Y | N | Y | | |
| 708 | 1 | Fitness Center | 131 | DHW | Y | N | Y | | |
| 710 | 1 | Admin. | N/A | N/A | Y | N | Y | | |
| 712 | 1 | Barracks | 135 | DHW | Y | N | Y | | |
| 713 | 1 | Barracks | 133 | DHW | Y | N | Y | | |
| 714 | 1 | Barracks | 137 | DHW | Y | N | Y | | |
| 715 | 1 | Barracks | 135 | DHW | Y | Y | N | 0.20 | ✓ |
| 717 | 1 | Barracks | 131 | DHW | Y | N | N | | |
| 718 | 1 | Barracks | 124 | DHW | Y | Y | Y | 0.20 | 2 ✓ |
| 719 | 1 | Barracks | 112 | DHW | Y | Y | N | 1.00 | ✓ |
| 720 | 1 | Barracks | 130 | DHW | Y | N | Y | | |
| 721 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 722 | 1 | Admin. | N/A | N/A | Y | Y | Y | 5.00 | ✓ |
| 723 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 724 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 725 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 726 | 1 | Dining Facility | 158 | DHW | Y | N | Y | | |
| 727 | N/A | Training Facility | N/A | N/A | Y | N/A | N | | |
| 728 | 1 | Admin. | N/A | N/A | Y | Y | N | 3.05 | 2 ✓ |
| 810 | 1 | Barracks | 131 | DHW | Y | N | N | | |
| 811 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 812 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 813 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 814 | 1 | Admin. | N/A | N/A | Y | N | Y | | |
| 815 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 816 | 1 | Admin. | N/A | N/A | Y | N | Y | | |
| 818 | 1 | Admin. | N/A | N/A | Y | N | N | | |
| 819 | 1 | Admin. | N/A | N/A | Y | Y | N | 0.13 | 3 ✓ |

Ø Flanges

11 Valves

MECH. ROOM HTW LEAKS

Fort Stewart - HTW Distribution System

Filename: FS-BLDGS.WB2

| Building No. | HTW Zone | Building Type | DHW Temp. | Water Sample | Mech Rm Survey | HTW Leaks | Other Leaks | HTW Drop/Sec | HTW Cup/Min | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1160 | 3 | D.S. Maint Fac | N/A | N/A | Y | Y | N | 2.03 | | 2V |
| 1170 | 3 | G.S. Maint Fac | N/A | N/A | Y | N | N | | | |
| 1208 | 1 | Tac Equip Shop | N/A | N/A | Y | N | Y | | | |
| 1209 | 1 | Tac Equip Shop | N/A | N/A | Y | N | N | | | |
| 1211 | 1 | Tac Equip Shop | N/A | N/A | Y | N | N | | | |
| 1245 | N/A | Tac Equip Shop | N/A | N/A | Y | N/A | Y | | | |
| 1259 | 1 | Tac Equip Shop | N/A | N/A | Y | Y | N | | 0.25 | V |
| 1261 | 2 | Tac Equip Shop | N/A | N/A | N | | | | | |
| 1265 | 2 | Tac Equip Shop | N/A | N/A | Y | N | N | | | |
| 1280 | N/A | Tac Equip Shop | N/A | N/A | Y | N/A | Y | | | |
| 1320 | 2 | Tac Equip Shop | N/A | N/A | Y | N | N | | | |
| 1330 | 2 | Tac Equip Shop | N/A | N/A | Y | Y | N | 0.13 | | V |
| 1340 | 2 | Tac Equip Shop | N/A | N/A | Y | N | N | | | |
| 1412 | | C. Energy Plant | N/A | HTW | Y | Y | | | | |
| 1500 | 3 | Div Logis Fac | N/A | N/A | w/ 1509? | | | | | |
| 1503 | 3 | Auto Hobby Shop | N/A | N/A | LOCKED | | | | | |
| 1509 | 3 | Div Logis Fac | N/A | N/A | Y | Y | Y | 3.00 | | V |
| 1510 | 3 | Tac Equip Shop | N/A | N/A | N | | | | | |
| 1540 | 3 | Tac Equip Shop | 95 | PW | N | | | | | |
| 1720 | 2 | D.S. Maint Fac | 148 | DHW | Y | N-N/A | N | | | |
| 1810 | 2 | Tac Equip Shop | N/A | N/A | N | | | | | |
| 1820 | 2 | Tac Equip Shop | N/A | N/A | Y | N-N/A | N | | | |
| 1840 | 2 | Tac Equip Shop | N/A | N/A | Y | N | Y | | | |
| 2115 | 1 | Dental Clinic | N/A | N/A | Y | N | N | | | |
| 2125 | 1 | Chapel | 120 | DHW | Y | N | N | | | |
| 3001 | S | S. Energy Plant | N/A | N/A | Y | Y | | | | |
| 3002 | S | Admin. | N/A | N/A | Y | Y | N | 5.20 | | F+V |
| 4502 | S | Tac Equip Shop | N/A | N/A | N | | | | | |
| 4528 | S | Tac Equip Shop | N/A | N/A | N | | | | | |
| 4577 | S | Tac Equip Shop | N/A | N/A | N | | | | | |
| 4578 | S | Tac Equip Shop | N/A | N/A | N | | | | | |
| TOTALS | | 140 | | | 127 | 42 | 41 | 55.11 Drop/Sec | 11.80 Cup/Min | |

| | | |
|---|---|---|
| Leaks (GPM) = | 0.138 | 0.737 |
| % of Total = | 16% | 84% |
| Total Leaks = | 0.875 GPM | |

1 Flange

6 Valves

HEATING EQUIP. & SEP LOSSES

**RS&H**

SUBJECT Fort Stewart HTW

DESIGNER W. T. TODD

CHECKER

AEP NO

SHEET OF

DATE

DATE

HTW losses during the heating season were substantially higher than the rest of 1995. These losses must be due to leaks in the SEP system and from building HVAC heating equipment.

| Month/Yr. | Avg. HTW Losses | Annual Avg. | Difference |
|---|---|---|---|
| Jan/95 | 9.0 GPM | 6.4 GPM | 2.6 GPM |
| Feb/95 | 11.0 GPM | 6.4 GPM | 4.6 GPM |
| Mar/95 | 8.1 GPM | 6.4 GPM | 1.7 GPM |

HEATING EQUIP. & SEP LOSSES:

$$2.6 \text{ GPM} \times 1440 \text{ min/day} \times 31 \text{ days} = 116{,}064 \text{ Gal}$$

$$4.6 \text{ GPM} \times 1440 \text{ min/day} \times 28 \text{ days} = 185472 \text{ Gal}$$

$$1.7 \text{ GPM} \times 1440 \text{ min/day} \times 31 \text{ days} = 75888 \text{ Gal}$$

$$\text{TOTAL} = 377{,}424 \text{ GAL}$$

$$377424 \text{ GAL/YR} \div 365 \text{ days/YR} = \underline{1034 \text{ Gal/Day}}$$

$$1034 \text{ GAL/DAY} \div 1440 \text{ min/day} = \underline{0.718 \text{ Gal/min}}$$

| | | | |
|---|---|---|---|
| SUBJECT | FORT STEWART | AEP NO | |
| | | SHEET | OF |
| DESIGNER | W. TODD | DATE | |
| CHECKER | | DATE | |

## SEP START-UP LOSSES

See calculations for ECO-9.

## HTW PIPING LEAKS - REPAIRED

Average loss during leak = 25000 Gal (see Figure 4.1-5)

Average loss w/o leak = 15000 Gal (see Figure 4.1-5)

Loss from leak = 10,000 Gal

Total losses = 10000 Gal/leak × 2 leaks = 20 000 GAL

20 000 GAL ÷ 365 day/YR = 55 GAL/DAY

55 GAL/DAY ÷ 1440 MIN/DAY = 0.038 GAL/MIN

# A.5 ENERGY DATA, BOILER LOGS AND MAKE-UP WATER DATA

Fort Stewart Central Energy Plant
Energy Consumption
Filename: FS-ENRGY.WQ1

| Month | Yr | Wood Tons (1) | Wood MBtu (2) | Wood Cost (2) | #2 Oil Gals (1) | #2 Oil MBtu (3) | #2 Oil Cost (3) | Used Oil Gals (4) | Used Oil MBtu (5) | Used Oil Cost (5) | N.Gas CuFt (1) | N.Gas MBtu (6) | N.Gas Cost (6) | Total MBtu | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | 94 | 6052 | 62941 | 65483 | 75497 | 10645 | 46808 | 0 | 0 | 0 | 5572730 | 5701 | 18563 | 79287 | 130854 |
| 8 | 94 | 8169 | 84958 | 88389 | 13822 | 1949 | 8570 | 12956 | 1749 | 0 | 874295 | 894 | 2878 | 89549 | 99836 |
| 9 | 94 | 4969 | 51678 | 53765 | 40667 | 5734 | 25214 | 17703 | 2390 | 0 | 352500 | 361 | 1056 | 60163 | 80034 |
| 10 | 94 | 3947 | 41049 | 42707 | 42608 | 6008 | 26417 | 18775 | 2535 | 0 | 598230 | 611 | 1790 | 50203 | 70913 |
| 11 | 94 | 5000 | 52000 | 54100 | 15884 | 2240 | 9848 | 24298 | 3280 | 0 | 1082030 | 1107 | 3488 | 58627 | 67436 |
| 12 | 94 | 6631 | 68964 | 71749 | 22257 | 3138 | 13799 | 9470 | 1278 | 0 | 1366090 | 1398 | 4363 | 74778 | 89912 |
| 1 | 95 | 6100 | 63441 | 66003 | 39741 | 5603 | 24639 | 8891 | 1200 | 0 | 1027820 | 1049 | 3199 | 71294 | 93841 |
| 2 | 95 | 5024 | 52250 | 54360 | 110411 | 15568 | 68455 | 13181 | 1779 | 0 | 1159730 | 1186 | 3368 | 70783 | 126182 |
| 3 | 95 | 5723 | 59519 | 61923 | 19404 | 2736 | 12030 | 11576 | 1563 | 0 | 518890 | 530 | 1463 | 64348 | 75417 |
| 4 | 95 | 1869 | 19438 | 20223 | 550 | 78 | 341 | 0 | 0 | 0 | 12995190 | 13268 | 37455 | 32783 | 58019 |
| 5 | 95 | 5322 | 55349 | 57584 | 6525 | 920 | 4046 | 11324 | 1529 | 0 | 550120 | 563 | 1724 | 58361 | 63354 |
| 6 | 95 | 4768 | 49587 | 51590 | 11466 | 1617 | 7109 | 5476 | 739 | 0 | 2081740 | 2128 | 6435 | 54071 | 65134 |
| Averages | | 5298 | 55098 | 57323 | 33236 | 4686 | 20606 | 11138 | 1504 | 0 | 2348280 | 2400 | 7148 | 63687 | 85078 |
| Totals | | 63574 | 661173 | 687874 | 398832 | 56235 | 247276 | 133650 | 18043 | 0 | 28179365 | 28796 | 85782 | 764246 | 1020931 |
| % of Total | | | 86.5% | 67.4% | | 7.4% | 24.2% | | 2.4% | 0.0% | | 3.8% | 8.4% | | |
| Avg Cost | | | $1.04 | /MBtu | | $4.40 | /MBtu | | $0.00 | /MBtu | | $2.98 | /MBtu | $1.34 | /MBtu |

(1) Source is Fort Stewart Operating Logs.
(2) Assumes 40% moisture and heating value of 5200 btu/lb; cost is $10.82/ton.
(3) Assumes heating value of 141000 btu/gal; cost is $0.62/gal.
(4) Source is monthly Oil Reports prepared at the CEP.
(5) Assumes heating value of 18000 btu/lb, 7.5 lb/gal; no cost.
(6) Uses heating value and cost from utility bills.

## ELECTRIC BILLS

DPW, SERVICE BRANCH
FAX NO. 767-7570

TO: Bill Todd, RS:H, Jax, Fl.
FROM: Dennie Kelley
DATE: 18 Aug 95
MESSAGE:
As Requested

$$\frac{\$3070487}{65{,}491{,}200\ \text{kwh}}$$

NO OF PAGES

Average elec. cost = $0.0469/kwh

A.5-4

PLEASE DO NOT STAPLE, FOLD OR PAPER CLIP

Georgia Power Company
96 Annex, Atlanta, Ga. 30396

1 0475 B

831853000402007250846530081095000000000

FORT STEWART
DPW
BLDG 1139
SERVICE BRANCH
FT STEWART GA 31314

Georgia Power Company
P. O. BOX 102473
68 ANNEX
ATLANTA GA 30368

REMIT TO ↑

725084.65 SVC 520

8318530004020

725084.65 XXXXXXXXXX

Total Net Due

PLEASE RETURN THIS PORTION WITH YOUR REMITTANCE.

| Account Number | Service Period From | To | | |
|---|---|---|---|---|
| 8318530004020 | 06-23 | 07-24-95 | DSO DB 0.934350%<br>FUEL CS $0.015097<br>ECON CR 0.009150% | |

Georgia Power Company
HINESVILLE GA 31313
(912) 368-3376

| RATE NAME | METER NO. | PRES READ | PREV READ | KWH CONST | KW HRS USED | BILL DEM | ACT DEM | ACT RKVA CD | Amount |
|---|---|---|---|---|---|---|---|---|---|
| 520 | E70396 | 4344 | 4110 | 19200 | 16608000 | 30701 | 30701 | 14632 | 725084.65 |
| | EXCESS RKVA | | | 4398 | | | | | |

CONSUMPTION FORWARDED METERS
E70398 0346 9715 19200

| Sales Tax | Local Tax | Date of Bill | Service Name and Location | PLEASE PAY BY | Total Net Due |
|---|---|---|---|---|---|
| *Current Bill Includes | | 0728 | FORT STEWART<br>DPW<br>HERO RD<br>FORT STEWART GA 31313 | 08-10-95 | 725084.65 |

PLEASE RETAIN THIS PORTION FOR YOUR RECORDS.
REFERENCE REVERSE SIDE FOR EXPLANATIONS AND DESCRIPTIONS OF RATE NAMES, ABBREVIATIONS AND BILLING CODES.

$$\frac{\$725{,}085}{16{,}608{,}000\ \text{KWH}} = \$0.0437/\text{kwh}$$

A.5-5

PLEASE DO NOT STAPLE, FOLD OR PAPER CLIP

Georgia Power Company
96 Annex, Atlanta, Ga. 30396

1 0480 B

8318530000402006613207430071195000000000

FORT STEWART
DPW
BLDG 1139
SERVICE BRANCH
FT STEWART GA 31314

Georgia Power Company
P. O. BOX 102473
68 ANNEX
ATLANTA GA 30368
REMIT TO

661320.74 SVC 520

8318530004020

661320.74 XXXXXXXXXX
Total Net Due

PLEASE RETURN THIS PORTION WITH YOUR REMITTANCE.

| Account Number | Service Period From | To | | |
|---|---|---|---|---|
| 8318530004020 | 05-24 | 06-23-95 | DSO DB 0.934350% FUEL CS $0.015097 ECON CR 0.009150% | |

Georgia Power Company
HINESVILLE GA 31313
(912) 368-3376

| RATE NAME | METER NO. | PRES READ | PREV READ | KWH CONST | KW HRS USED | BILL DEM | ACT DEM | ACT RKVA | CD | Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| 520 | E70396 | 4110 | 3898 | 19200 | 14515200 | 29818 | 29818 | 14355 | | 661320.74 |
| | EXCESS RKVA | | | 4416 | | | | | | |

CONSUMPTION FORWARDED METERS
E70398 9715 9171 19200

Rec'd 6 Jul 95
Dennis Kelley

| Sales Tax | Local Tax | Date of Bill | Service Name and Location | PLEASE PAY BY | Total Net Due |
|---|---|---|---|---|---|
| *Current Bill Includes | | 0629 | FORT STEWART DPW HERO RD FORT STEWART GA 31313 | 07-11-95 | 661320.74 |

PLEASE RETAIN THIS PORTION FOR YOUR RECORDS.
REFERENCE REVERSE SIDE FOR EXPLANATIONS AND DESCRIPTIONS OF RATE NAMES, ABBREVIATIONS AND BILLING CODES.

$$\frac{\$661,321}{14,515,200 \text{ kwh}} = \$0.0456/\text{kwh}$$

A.5-6

PLEASE DO NOT STAPLE, FOLD OR PAPER CLIP

Georgia Power Company
96 Annex, Atlanta, Ga. 30396

1 0479 B

8318530004020060430008800612950000000000

FORT STEWART
DPW
BLDG 1139
SERVICE BRANCH
FT STEWART GA 31314

Georgia Power Company
P. O. BOX 102473
68 ANNEX
ATLANTA GA 30368

REMIT TO ↑

604300.08 SVC 520

8318530004020

604300.08 XXXXXXXXXXX

Total Net Due

PLEASE RETURN THIS PORTION WITH YOUR REMITTANCE.

| Account Number | Service Period From | To | | |
|---|---|---|---|---|
| 8318530004020 | 04-24 | 05-24-95 | DSO DB 0.934350% FUEL CS $0.015097 ECON CR 0.009150% | |

Georgia Power Company
HINESVILLE GA 31313
(912) 368-3376

| RATE NAME | METER NO. | PRES READ | PREV READ | KWH CONST | KW HRS USED | BILL DEM | ACT DEM | ACT RKVA | CD | Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| 520 | E70396 | 3898 | 3688 | 19200 | 13056000 | 27816 | 27725 | 13014 | | 604300.08 |
| | EXCESS RKVA | | | 3772 | | | | | | |

CONSUMPTION FORWARDED METERS
E70398 9171 8701 19200

| Sales Tax | Local Tax | Date of Bill | Service Name and Location | PLEASE PAY BY | Total Net Due |
|---|---|---|---|---|---|
| | | 0531 | FORT STEWART DPW HERO RD FORT STEWART GA 31313 | 06-12-95 | 604300.08 |

*Current Bill Includes

PLEASE RETAIN THIS PORTION FOR YOUR RECORDS.
REFERENCE REVERSE SIDE FOR EXPLANATIONS AND DESCRIPTIONS OF RATE NAMES, ABBREVIATIONS AND BILLING CODES.

$$\frac{\$604,300}{13,056,000\ \text{kwh}} = \$0.0463/\text{kwh}$$

A.5-7

PLEASE DO NOT STAPLE, FOLD OR PAPER CLIP

Georgia Power Company
96 Annex, Atlanta, Ga. 30396

1 0483 B

8318530004020052415114000510950000000000

FORT STEWART
DPW
BLDG 1139
SERVICE BRANCH
FT STEWART GA 31314

Georgia Power Company
P. O. BOX 102473
68 ANNEX
ATLANTA GA 30368
REMIT TO ↑

| | |
|---|---|
| 524151.14 | SVC 520 |
| 524151.14 | XXXXXXXXXX |
| Total Net Due | |

8318530004020

PLEASE RETURN THIS PORTION WITH YOUR REMITTANCE.

| Account Number | Service Period From | Service Period To | |
|---|---|---|---|
| 8318530004020 | 03-27 | 04-24-95 | DSO DB 0.934350% FUEL CS $0.015097 ECON CR 0.005660% |

Georgia Power Company
HINESVILLE GA 31313
(912) 368-3376

| RATE NAME | METER NO. | PRES READ | PREV READ | KWH CONST | KW HRS USED | BILL DEM | ACT DEM | ACT RKVA | CD | Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| 520 | E70396 | 3688 | 3506 | 19200 | 10060800 | 27816 | 24058 | 11096 | | 524151.14 |
| | EXCESS RKVA | | | 3077 | | | | | | |

CONSUMPTION FORWARDED METERS
E70398 8701 8359 19200

| Sales Tax | Local Tax | Date of Bill | Service Name and Location | PLEASE PAY BY | Total Net Due |
|---|---|---|---|---|---|
| | | 0428 | FORT STEWART DPW HERO RD FORT STEWART GA 31313 | 05-10-95 | 524151.14 |

*Current Bill Includes

PLEASE RETAIN THIS PORTION FOR YOUR RECORDS.
REFERENCE REVERSE SIDE FOR EXPLANATIONS AND DESCRIPTIONS OF RATE NAMES, ABBREVIATIONS AND BILLING CODES.

$$\frac{\$524{,}151}{10{,}060{,}800 \text{ kwh}} = \$0.0521/\text{kwh}$$

A.5-8

PLEASE DO NOT STAPLE, FOLD OR PAPER CLIP

Georgia Power Company
96 Annex, Atlanta, Ga. 30396

1 0482 B

83185300040200555629843004119500000000000

FORT STEWART
DPW
BLDG 1139
SERVICE BRANCH
FT STEWART GA 31314

Georgia Power Company
P. O. BOX 102473
68 ANNEX
ATLANTA GA 30368

REMIT TO ↑

| | |
|---|---|
| 555629.84 | SVC 520 |
| 555629.84 | XXXXXXXXXX |
| Total Net Due | |

8318530004020

PLEASE RETURN THIS PORTION WITH YOUR REMITTANCE.

| Account Number | Service Period From | To |
|---|---|---|
| 8318530004020 | 02-22 | 03-27-95 |

DSO DB 0.934350%
FUEL CS $0.015097
ECON CR 0.005660%

Georgia Power Company
HINESVILLE GA 31313
(912) 368-3376

| RATE NAME | METER NO. | PRES READ | PREV READ | KWH CONST | KW HRS USED | BILL DEM | ACT DEM | ACT RKVA | CD | Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| 520 | E70396 | 3506 | 3307 | 19200 | 11251200 | 27816 | 19238 | 8358 | | 555629.84 |
| | EXCESS RKVA | | | 1945 | | | | | | |

CONSUMPTION FORWARDED METERS
E70398 8359 7972 19200

| Sales Tax | Local Tax | Date of Bill | Service Name and Location | PLEASE PAY BY | Total Net Due |
|---|---|---|---|---|---|
| | | 0331 | FORT STEWART DPW HERO RD FORT STEWART GA 31313 | 04-11-95 | 555629.84 |

*Current Bill Includes

PLEASE RETAIN THIS PORTION FOR YOUR RECORDS.
REFERENCE REVERSE SIDE FOR EXPLANATIONS AND DESCRIPTIONS OF RATE NAMES, ABBREVIATIONS AND BILLING CODES.

$$\frac{\$555,630}{11,251,200\ \text{kwh}} = \$0.0494/\text{kwh}$$

# GEORGIA POWER COMPANY

## Full Use Service to Governmental Institutions

SCHEDULE "G-10"

AVAILABILITY:

Throughout the Company's service area from existing lines of adequate capacity, except that service under this tariff is not available to a customer who is served from an underground network system or who applies for service after December 29, 1981 at a service level below 12 kV.

APPLICABILITY:

Full use service to large Federal, State, and Municipal agencies and institutions at a single delivery point through a single meter. This schedule is not applicable to Housing Projects or other Governmental agencies or Institutions whose service requirements are predominantly residential, nor is it available to any customer who has more than one meter per structure.

TYPE OF SERVICE:

Single or three phase, 60 hertz, at a standard voltage.

MONTHLY RATE - Energy Charge Including Demand Charge:

**Base Charge ........................................ $55.00**

**All consumption (kWh) not greater than 300 hours times the billing demand:**

| | | |
|---|---|---|
| **First 50,000 kWh** | @ | **6.00¢ per kWh** |
| **Next 150,000 kWh** | @ | **5.82¢ per kWh** |
| **Next 800,000 kWh** | @ | **4.42¢ per kWh** |
| **Over 1,000,000 kWh** | @ | **4.10¢ per kWh** |

| | | |
|---|---|---|
| **All consumption (kWh) in excess of 300 hours times the billing demand** | @ | **1.15¢ per kWh** |

**Minimum Monthly Bill:**

**$55.00 Base Charge plus $8.00 per kW of Billing Demand, but not less than $3,400.00 per month, plus excess kVAR charges and Fuel Cost Recovery as applied to the current month kWh.**

FUEL COST RECOVERY:

The amount calculated at the above rate will be increased under the provisions of the Company's effective Fuel Cost Recovery Schedule, including any applicable adjustments.

DETERMINATION OF BILLING DEMAND:

The Billing Demand shall be based on the highest 30-minute kW measurement during the current month and the preceding eleven (11) months.

For the billing months of June through **September**, the Billing Demand shall be the greatest of:
(1) The current actual demand, or,
(2) Ninety-Five percent (95%) of the highest actual demand occurring in any previous applicable summer month (June through September), or,
(3) Sixty percent (60%) of the highest actual demand occurring in any previous applicable winter month (October through May).

For the billing months of **October** through **May**, the Billing Demand shall be the greater of:
(1) Ninety-Five percent (95%) of the highest summer month (June through September), or,
(2) Sixty percent (60%) of the highest winter month (October through May), including the current month.

In no case shall the Billing Demand be less than the greatest of:
(1) The contract minimum, or,
(2) Fifty percent (50%) of the total contract capacity, or,
(3) 3,000 kW for any customer applying for service under this rate subsequent to December 22, 1971, or,
(4) 6,000 kW for any customer applying for service under this rate subsequent to December 29, 1981.

Where there is an indiction of a power factor of less than 95% lagging, the Company may, at its option, install metering equipment to measure Reactive Demand. The Reactive Demand shall be the highest 30-minute kVAR measured during the month. The Excess Reactive Demand shall be kVAR which is in excess of one-third of the measured actual kW in the current month. The Company will bill excess kVAR at the rate of $0.27 per excess kVAR.

TERM OF CONTRACT:

Not less than one year.

REVENUE ADJUSTMENT:

The bill calculated at the above rate is subject to change in such an amount as may be determined under the provisions of the Company's Revenue Adjustment Rider, Schedule "RA-1", as approved by the Georgia Public Service Commission or as may be later amended.

Service hereunder subject to Rules and Regulations for Electric Service on file with the Georgia Public Service Commission.

Sub station capacity –
Evans –
Pembroke –

# FUEL OIL REPORTS

Denise Kelly
797-

# Oil Report Jan 94

$0.59 Budget
$0.694 Actual 10/94

| | | |
|---|---|---|
| OH | 174,119 | |
| Rec | 41,987 | From Hunter |
| Total | 216,106 | |
| Used | 66,349 | |
| OH | 149,757 | |

ON HAND

CEP 125,813
Ldry 23,044

Natural Gas Used 31,190 Cu. Ft. $

Wood Fuel Tons

$10.82/Ton

— May 96

| | | |
|---|---|---|
| OH | -0- | |
| Rec | 7503.20 | Tickets 19776-20036 |
| Total | 7503.20 | |
| Used | 6627.00 | |
| OH | 875.20 | |

# Oil Report Feb 94

OH 149,757
Rec 5,861 Used Oil
Total 155,618
Used 19,539 [(13,678 #2 Oil)(5861 Used Oil)]
OH 136,079

CEP 112,135
Ldry 23,944

Natural Gas 2,548 Cu. Ft.

Wood Fuel Tons

OH 875.20
Rec 8470.69
Total 9345.89
Used 5845.89
OH 3500.00

Tickets 20037-20328

# Oil Report Mar 94

OH 136,079
Rec -0-
Total 136,079
Used 5,736 #2 Oil (-0-Reclaimed Oil)
OH 130,343

CEP 106,399
Ldry 23,944

Natural Gas 6160 Cu. ft.

Wood Fuel Tons

OH 3500.00
Rec 6,608.03
Total 10,108.03
Used 5,884.00
OH 4,224.03

Tickets 20329-20554

# Oil Report April 94

OH 130,343
Rec -0-
Total 130,343
Used 4,412 #2 (-0- Used Oil)
OH 125,931

CEP 101,987
Ldry 23,944

Natural Gas 1,714,010 Cu. ft.

Wood Fuel Tons

OH 4,224.03
Rec 2996.84
Total 7220.87
Used 6870.87
OH 350.00

Tickets 20555 - 20658
Ticket 20658 Void

# Oil Report May 94

OH 125,931
Rec -0-
Total 125,931
Used 4853 #2(-0-used oil)
OH 121,078

CEP 97,134
Ldry 23,944

Natural Gas 11,816,530 Cu. ft

Wood Fuel Tons

OH 350.00
Rec 6458.66
Total 6808.66
Used 5374.00
OH 1434.66

Tickets 20659 - 20885

# Oil Report June 94

OH 121,078
Rec 181,200 From HAAF
Total 302,278
Used 184,388 #2 (-0- Used Oil)
O.H. 117,890

CEP 93,971
Ldry 23,919

Natural Gas 18,922,740 Cu.Ft.

Wood Fuel Tons

OH 1434.66
Rec 1299.07
Total 2733.73
Used 613.00
OH 2120.73

Tickets 20886-20931

Oil Report July 94

OH 117,890
Rec 127,639 From HAAF
Total 245,529
Used 75,497 #2 oil (-0- used oil)
OH 170,032

CEP 146,113
Ldry 23,919

Natural Gas 5570,730 Cu. ft.

Wood Fuel Tons

OH 2120.73
Rec 7,272.60
Total 9,393.33
Used 6,052.00
OH 3,341.33

# Oil Report Aug 94

OH 170,032
Rec 15,146 #2 Heating Oil from FS
Rec 12,956 Used Oil
Total 198,134
Used 26,778 (Used Oil 12,956 ✓)(13,822 ✓ #2 Oil)
OH 171,356

CEP 147,437
Ldry 23,919

Natural Gas Used 874,295 Cu. ft. ✓

Wood Fuel Tons

OH 3,341.33
Rec. 5321.54
Total 8662.87
Used 8169.00 ✓
OH 493.87

Tickets 21193–21383

# Oil Report Sept 94

| | | | | |
|---|---|---|---|---|
| OH | 171,356 | | CEP | 110,370 |
| Rec | 3600 #2 Heating Oil from F.S. | | Ldry | 23,919 |
| Rec | 17,703 Used Oil | | | |
| Total | 192,659 | | | |
| Used | 58,370 (17,703 Used Oil) (40,667 #2 Oil) | | | |
| OH | 134,289 | | | |

Natural Gas Used 352,500 Cu. ft.

Wood Fuel Tons

| | | |
|---|---|---|
| OH | 493.87 | |
| Rec | 7,123.66 | Tickets 21384-21644 |
| Total | 7617.47 | |
| Used | 4969.00 | |
| OH | 2648.47 | |

# OIL REPORT OCT 94

OH 134,289 CEP 267,515

REC 199,753 From Contractor Ldry 23,919

REC 18,775 Reclamed oil

TOTAL 352,817

USED 61,383 (18,775 Reclamed oil)(42,608 #2 Heating oil)

OH 291,434 [illegible] )

NATUral Gas used 598,230

WOOD Fuel Tons

OH 2648.47

REC 6999.43

TOTAL 9647.90

USED 3947.00

OH 5700.90

Ticket 21645 Void

Tickets 21646 - 21877

# OIL REPORT NOV 94

| | | | | |
|---|---|---|---|---|
| OH | 291,434 | | CEP | 237,717 |
| REC | 24,298 | RECLAMED OIL | Ldry | 23,919 |
| TOTAL | 315,732 | | | |
| USED | 54,096 | (24,298 Reclamed oil) (29,798 #2 Heating oil) | | |
| OH | 261,636 | | | |

See next page

NATURAL GAS 1,082,030 ✓

WOOD FUEL TONS

| | |
|---|---|
| OH | 5700.90 |
| REC | 5465.80 |
| TOTAL | 11,166.70 |
| USED | 5,000 ✓ |
| OH | 6166.70 |

TICKETS 21889 - 22080

CORRECTED COPY OF NOV 94 OIL REPORT

| | | | |
|---|---|---|---|
| OH | 291,434 | CEP | 251,631 |
| REC | 24,298 Used O.l | LDRY | 23,919 |
| TOTAL | 315,732 | | |
| USED | 40,182 (24,298 used O.l)(15,884 #2 O.l) | | |
| OH | 275,550 | | |

Corrected copy necessary due to a 13,914 Gallion EARROW in TANK sounding

OIL REPORT DEC 94

OH 261,636 CEP 215,460

REC 9,470 RECLAMED OIL LDRY 23,919

TOTAL 271,106

USED 31,727 (9,470 Reclamed oil) (22,257 # 2 HEATING OIL)

OH 239,379

OIL ACTUALLY USED WAS 13,914 GALLIONS MORE THAN SHOWED IN USED COLUMN ABOVE, DUE TO ERROW IN NOV 94, REPORT.

NATURAL GAS 1,366,090 ✓

WOOD FUEL TONS TICKETS

OH 6166.70 22081— 22231

REC 4264.48

TOTAL 10431.18

USED 6631.18 ✓

OH 3800.00

# OIL REPORT JAN 95

OH 239,379
REC 8,891 Reclamed oil
TOTAL 248,270
USED $\boxed{48,632}$ (8891 Reclamed oil) (39,741 #2 Heating oil)
OH 199,638

CEP 175,759
LDRY 23,879

NATURAL GAS $\boxed{1,072,820}$ CF

WOOD FUEL TONS

OH 3800.00
REC 4996.10
TOTAL 8796.10
USED $\boxed{6100.10}$
OH 2696.00

TICKET 22232-22426
TICKET 22363 VOID

Janas

POL MONTHLY REPORT

Diane ~~Jay~~ 5440

FORT STEWART - FS#2

OPENING INVENTORY 239,379

RECEIPTS 31,291

BLDG 1412 8891
POSTWIDE 22400

ISSUES 71,032

BLDG 1412 48632
POSTWIDE 22400

BOOK BALANCE 199,638

DIFFERENCE (+ or -) —

CLOSING INVENTORY 199,638

FORT STEWART - FUEL OIL RECOVERED

8891

REMARKS:

DATE 2 Feb 95 SIGNATURE Denise Kelly

OIL REPORT JAN 95

| | | | | |
|---|---|---|---|---|
| O.H | 239,379 | | C.E.P | 175,759 |
| REC | 8,891 | Reclamed oil | LDRY | 23,579 |
| TOTAL | 248,270 | | | |
| USED | $\boxed{48,632}$ | (8891 Reclamed oil)(39,741 AZ Heating oil) | | |
| OH | 199,638 | | | |

NATURAL GAS $\boxed{1,072,820}$ CF

WOOD FUEL TONS

| | | |
|---|---|---|
| OH | 3800.00 | TICKET 22232-22426 |
| REC | 4996.10 | TICKET 22363 VOID |
| TOTAL | 8796.10 | |
| USED | $\boxed{6100.10}$ | |
| OH | 2696.00 | |

# OIL REPORT FEB 95

OH 199,638 CEP 230,461
REC 13,181 (Reclamed oil) L DRY 23,819
REC 165,053 (#2 HEATING oil From Contractor)
TOTAL 377,872
USED 123,592 (13,181 Reclamed oil) (110,411 #2 HEATING oil)
OH 254,280

NATURAL GAS 1,159,730 CF

WOOD FUEL TONS

OH 2696.00
REC 7116.96
TOTAL 9812.96
USED 5024.00
OH 4788.96

TICKET 22427 - 22696
TICKET 22696 VOID

# OIL REPORT MARCH 95

OH 254,280 CEP 211057
REC 11,576 (RECLAIMED OIL) LORY 23,819
TOTAL 265,856
USED 30,980 (11,576 RECLAIMED OIL) (19,404 #2 HEATING OIL)
OH 234,876

NATURAL GAS 518,890 CF

WOOD FUEL TONS TICKET 22697-22852
OH 4788-96
REC 4076-56
TOTAL 8865-52
USED 5723-00
OH 3142-52

# OIL REPORT APRIL 95

OH 234,876
REC 638 (FROM UNITS)
TOTAL 235,514
USED 550 ✓ (#2 HEATING OIL)
OH 234,964

CEP 21145
LORY 23,819

## NATURAL GAS

12,995,190 CE

## WOOD FUEL TONS

OH 3142.52
REC 897.77
TOTAL 4040.29
USED 1869.00
OH 2171.29

TICKET 22853 – 22888

# OIL REPORT MAY 95

OH 234,964 CEP 234,989
REC 30,369 FROM UNITS LDRY 23,819
REC 11,324 RECLAMED OIL
TOTAL 276,657
USED 17,849 (11,324 RECLAMED OIL)( 6,525 #2 HEATING OIL)
OH 258,808

NATURAL GAS 550,120 CF

WOOD FUEL TONS

OH 2171.29
REC 4851.67
TOTAL 7022.96
USED 5322.00
OH 1700.96

Tickets 22890-23069
TICKET 22889 void

# OIL REPORT JUNE 95

OH 258,808 CEP 223,523
REC 5,476 (RECLAIMED OIL) LORY 23,819
TOTAL 264,284
USED 16,942 (5476 RECLAIMED OIL) (11,466 #2 HEATING OIL)
OH 247,342

NATURAL GAS 2,081,740 CF

WOOD FUEL TONS

OH 1700.96 TICKET 23070 - 23302
REC 6322.41 TICKET 23294 + 23295 VOID
TOTAL 8023.37
USED 4768.00
OH 3255.37

# OIL REPORT JULY 95

| | | | |
|---|---|---|---|
| OH | 247,342 | CEP | 218,672 |
| REC | 10,615 | LDRY | 23,819 |
| TOTAL | 257,957 | | |
| USED | 15,466 | (10,615 RECLAMED OIL) (4,851 #2 HEATING OIL) | |
| OH | 242,491 | | |

NATURAL GAS
3,381,820 CU. FT.

WOOD FUEL TONS

| | | |
|---|---|---|
| OH | 3255.37 | TICKET 23303 - 23524 |
| REC | 5805.28 | |
| TOTAL | 9060.65 | |
| USED | 5316.00 | |
| OH | 3744.65 | |

# DPW, SERVICE BRANCH
FAX NO. 767-7570

TO: Bill Todd, RS:H, Jay, Fl.

FROM: Denise Kelley

DATE: 9 Aug 95

MESSAGE:

As Requested

NO OF PAGES

# NATURAL GAS BILLS

ATLANTA GAS LIGHT COMPANY - GEORGIA NATURAL GAS - SAVANNAH NATURAL GAS COMPANY
P.O.BOX 105256 ATLANTA, GA 30348-5256

INTERRUPTIBLE MONTHLY BILLING INVOICE JULY, 1994

U S ARMY - FT. STEWART
ARTILLERY FIRING CTR

ACCOUNT 23558-0300-0-8
I-20 COMMERCIAL RATE

DISTRICT 4630267

| METER NUMBER | USAGE | TEMPERATURE FACT. |
|---|---|---|
| 686 | 5840 | 1.0000000 |
| 5141 | 6647 | 1.0000000 |

TOTAL MCF METERED 12487

CONVERT TO THERMS (10.23 /MCF X NET MCF = 127,738 )

---

MONTHLY CUSTOMER CHARGE (BASED ON 93/12 USAGE OF 347,985 THERMS) $1,100.00

| | THERMS | CENTS/THM | AMOUNT |
|---|---|---|---|
| I-20 COMMODITY CHARGE | 127,738 | 6.950 | 8,877.79 |
| I-20 SEASONAL SUPPLY COST | 127,738 | 24.750 | 31,615.16 |
| BASE TAKE OR PAY COST | 127,738 | .000 | 0.00 |
| BASE ENVIRONMENTAL RESPONSE COST | 127,738 | .000 | 0.00 |
| SUB TOTAL | | | 41,592.95 |
| .00 % SALES TAX | | | 0.00 |
| TOTAL CURRENT AMOUNT | | | $41,592.95 |
| TOTAL CURRENT CHARGES | | | $41,592.95 |

Svcs Rec'd
15 Aug 94
Dennis Kelley

A.5-37

REPORT ID: [illegible]51 521 - JESUP-WAYCROSS
RUN DATE : 08/08/94

U S ARMY - FT. STEWART

ATLANTA GAS LIGHT COMPANY
INTERRUPTIBLE CUSTOMER WORKSHEET (THERMS)
ACCOUNT # 23558 0300 0 8



JULY

| | TOTAL VOLUMES METERED WITH BTU FACTOR OF 10.23 | I-20 INTERRUPTIBLE TOTAL USED | I-20 SEASONAL SUPPLY USED |
|---|---|---|---|
| 1 | 10,312 | 10,312 | 10,312 |
| 2 | 9,667 | 9,667 | 9,667 |
| 3 | 9,616 | 9,616 | 9,616 |
| 4 | 10,220 | 10,220 | 10,220 |
| 5 | 11,089 | 11,089 | 11,089 |
| 6 | 11,048 | 11,048 | 11,043 |
| 7 | 11,110 | 11,110 | 11,110 |
| 8 | 10,598 | 10,598 | 10,598 |
| 9 | 3,274 | 3,274 | 3,274 |
| 10 | 2,619 | 2,619 | 2,619 |
| 11 | 2,107 | 2,107 | 2,107 |
| 12 | 2,066 | 2,066 | 2,066 |
| 13 | 2,046 | 2,046 | 2,046 |
| 14 | 2,015 | 2,015 | 2,015 |
| 15 | 1,565 | 1,565 | 1,565 |
| 16 | 1,166 | 1,166 | 1,166 |
| 17 | 1,708 | 1,708 | 1,708 |
| 18 | 2,036 | 2,036 | 2,036 |
| 19 | 1,974 | 1,974 | 1,974 |
| 20 | 2,107 | 2,107 | 2,107 |
| 21 | 2,066 | 2,066 | 2,066 |
| 22 | 1,463 | 1,463 | 1,463 |
| 23 | 1,228 | 1,228 | 1,228 |
| 24 | 1,749 | 1,749 | 1,749 |
| 25 | 2,015 | 2,015 | 2,015 |
| 26 | 2,118 | 2,118 | 2,118 |
| 27 | 1,964 | 1,964 | 1,964 |
| 28 | 1,882 | 1,882 | 1,882 |
| 29 | 1,586 | 1,586 | 1,586 |
| 30 | 1,616 | 1,616 | 1,616 |
| 31 | 1,708 | 1,708 | 1,708 |
| DAILY TOTAL | 127,738 | 127,738 | 127,738 |
| EXCESS REALLOC | | | |
| GRAND TOTAL | 127,738 | 127,738 | 127,738 |

A.5-38

ATLANTA GAS LIGHT COMPANY - GEORGIA NATURAL GAS - SAVANNAH NATURAL GAS COMPANY
P.O.BOX 105256 ATLANTA, GA 30348-5256

INTERRUPTIBLE MONTHLY BILLING INVOICE AUGUST, 1994

U S ARMY - FT. STEWART
ARTILLERY FIRING CTR

ACCOUNT 23558-0300-0-8
I-20 COMMERCIAL RATE

DISTRICT 4630267

| METER NUMBER | USAGE | TEMPERATURE FACT. |
|---|---|---|
| 686 | 2852 | 1.0000000 |
| 5141 | 3279 | 1.0000000 |
| TOTAL MCF METERED | 6131 | |

CONVERT TO THERMS (10.22 /MCF X NET MCF = 62,658 )

---

MONTHLY CUSTOMER CHARGE (BASED ON 93/12 USAGE OF 347,985 THERMS) $1,100.00

| | THERMS | CENTS/THM | AMOUNT |
|---|---|---|---|
| I-20 COMMODITY CHARGE | 62,658 | 6.950 | 4,354.73 |
| I-20 SEASONAL SUPPLY COST | 62,658 | 23.500 | 14,724.63 |
| BASE TAKE OR PAY COST | 62,658 | .000 | 0.00 |
| BASE ENVIRONMENTAL RESPONSE COST | 62,658 | .000 | 0.00 |
| SUB TOTAL | | | 20,179.36 |
| .00 % SALES TAX | | | 0.00 |
| TOTAL CURRENT AMOUNT | | | $20,179.36 |
| TOTAL CURRENT CHARGES | | | $20,179.36 |

Svcs Rec'd
19 Sep 94
Denise Kelley

A.5-39

EPORT ID: CMAM0051    521 - JESUP-WAYCROSS
UN DATE : 09/12/94

ATLANTA GAS LIGHT COMPANY
INTERRUPTIBLE CUSTOMER WORKSHEET (THERMS)
ACCOUNT # 23558 0300 0 8



U S ARMY - FT. STEWART

AUGUST

| | TOTAL VOLUMES METERED WITH BTU FACTOR OF 10.22 | I-20 INTERRUPTIBLE TOTAL USED | I-20 SEASONAL SUPPLY USED |
|---|---|---|---|
| 1 | 2,238 | 2,238 | 2,238 |
| 2 | 2,259 | 2,259 | 2,259 |
| 3 | 2,167 | 2,167 | 2,167 |
| 4 | 2,320 | 2,320 | 2,320 |
| 5 | 2,259 | 2,259 | 2,259 |
| 6 | 1,635 | 1,635 | 1,635 |
| 7 | 2,003 | 2,003 | 2,003 |
| 8 | 2,075 | 2,075 | 2,075 |
| 9 | 2,575 | 2,575 | 2,575 |
| 10 | 2,678 | 2,678 | 2,678 |
| 11 | 1,870 | 1,870 | 1,870 |
| 12 | 1,421 | 1,421 | 1,421 |
| 13 | 1,216 | 1,216 | 1,216 |
| 14 | 2,064 | 2,064 | 2,064 |
| 15 | 2,494 | 2,494 | 2,494 |
| 16 | 2,259 | 2,259 | 2,259 |
| 17 | 2,197 | 2,197 | 2,197 |
| 18 | 2,095 | 2,095 | 2,095 |
| 19 | 1,921 | 1,921 | 1,921 |
| 20 | 1,870 | 1,870 | 1,870 |
| 21 | 1,942 | 1,942 | 1,942 |
| 22 | 2,064 | 2,064 | 2,064 |
| 23 | 2,146 | 2,146 | 2,146 |
| 24 | 2,054 | 2,054 | 2,054 |
| 25 | 2,146 | 2,146 | 2,146 |
| 26 | 1,533 | 1,533 | 1,533 |
| 27 | 1,267 | 1,267 | 1,267 |
| 28 | 1,758 | 1,758 | 1,758 |
| 29 | 2,085 | 2,085 | 2,085 |
| 30 | 2,075 | 2,075 | 2,075 |
| 31 | 1,972 | 1,972 | 1,972 |
| AILY TOTAL | 62,658 | 62,658 | 62,658 |
| XCESS REALLOC | | | |
| RAND TOTAL | 62,658 | 62,658 | 62,658 |

A.5-40

ATLANTA GAS LIGHT COMPANY - GEORGIA NATURAL GAS - SAVANNAH NATURAL GAS COMPANY
P.O.BOX 105256 ATLANTA, GA 30348-5256

INTERRUPTIBLE MONTHLY BILLING INVOICE SEPTEMBER, 1994

U S ARMY - FT. STEWART
ARTILLERY FIRING CTR

ACCOUNT 23558-0300-0-8
I-20 COMMERCIAL RATE

DISTRICT 4630267

| METER NUMBER | USAGE | TEMPERATURE FACT. |
|---|---|---|
| 686 | 2552 | 1.0000000 |
| 5141 | 3214 | 1.0000000 |
| TOTAL MCF METERED | 5766 | |

CONVERT TO THERMS (10.24 /MCF X NET MCF = 59,041 )

MONTHLY CUSTOMER CHARGE (BASED ON 93/12 USAGE OF 347,985 THERMS) $1,100.00

| | THERMS | CENTS/THM | AMOUNT |
|---|---|---|---|
| I-20 COMMODITY CHARGE | 59,041 | 6.950 | 4,103.35 |
| I-20 SEASONAL SUPPLY COST | 59,041 | 20.430 | 12,062.08 |
| BASE TAKE OR PAY COST | 59,041 | .000 | 0.00 |
| BASE ENVIRONMENTAL RESPONSE COST | 59,041 | .000 | 0.00 |
| SUB TOTAL | | | 17,265.43 |
| .00 % SALES TAX | | | 0.00 |
| TOTAL CURRENT AMOUNT | | | $17,265.43 |
| TOTAL CURRENT CHARGES | | | $17,265.43 |

EPORT ID: CHAM0051    521 - JESUP-WAYCROSS
JN DATE : 10/07/94

# ATLANTA GAS LIGHT COMPANY
## INTERRUPTIBLE CUSTOMER WORKSHEET (THERMS)
ACCOUNT # 23558 0300 0 8


RUN TIME: 11:52
CMAB269-1

U S ARMY - FT. STEWART

EPTEMBER

| | TOTAL VOLUMES METERED WITH BTU FACTOR OF 10.24 | I-20 INTERRUPTIBLE TOTAL USED | I-20 SEASONAL SUPPLY USED |
|---|---|---|---|
| 1 | 1,884 | 1,884 | 1,884 |
| 2 | 1,413 | 1,413 | 1,413 |
| 3 | 1,229 | 1,229 | 1,229 |
| 4 | 1,229 | 1,229 | 1,229 |
| 5 | 4,485 | 4,485 | 4,485 |
| 6 | 2,109 | 2,109 | 2,109 |
| 7 | 2,109 | 2,109 | 2,109 |
| 8 | 2,621 | 2,621 | 2,621 |
| 9 | 1,669 | 1,669 | 1,669 |
| 10 | 2,509 | 2,509 | 2,509 |
| 11 | 1,823 | 1,823 | 1,823 |
| 12 | 2,181 | 2,181 | 2,181 |
| 13 | 2,068 | 2,068 | 2,068 |
| 14 | 2,099 | 2,099 | 2,099 |
| 15 | 2,017 | 2,017 | 2,017 |
| 16 | 1,536 | 1,536 | 1,536 |
| 17 | 1,270 | 1,270 | 1,270 |
| 18 | 1,843 | 1,843 | 1,843 |
| 19 | 2,099 | 2,099 | 2,099 |
| 20 | 2,099 | 2,099 | 2,099 |
| 21 | 2,099 | 2,099 | 2,099 |
| 22 | 1,966 | 1,966 | 1,966 |
| 23 | 1,577 | 1,577 | 1,577 |
| 24 | 1,188 | 1,188 | 1,188 |
| 25 | 1,915 | 1,915 | 1,915 |
| 26 | 2,140 | 2,140 | 2,140 |
| 27 | 2,150 | 2,150 | 2,150 |
| 28 | 2,171 | 2,171 | 2,171 |
| 29 | 1,997 | 1,997 | 1,997 |
| 30 | 1,546 | 1,546 | 1,546 |
| 31 | 0 | 0 | 0 |
| AILY TOTAL | 59,041 | 59,041 | 59,041 |
| XCESS REALLOC | | | |
| RAND TOTAL | 59,041 | 59,041 | 59,041 |

A.5-42

ATLANTA GAS LIGHT COMPANY - GEORGIA NATURAL GAS - SAVANNAH NATURAL GAS COMPANY
P.O.BOX 105256 ATLANTA, GA 30348-5256

CMA

INTERRUPTIBLE MONTHLY BILLING INVOICE OCTOBER, 1994

U S ARMY - FT. STEWART
ARTILLERY FIRING CTR

ACCOUNT 23558-0300-0-8
I-20 COMMERCIAL RATE

DISTRICT 4630267

| METER NUMBER | USAGE | TEMPERATURE FACT. |
|---|---|---|
| 686 | 3251 | 1.0000000 |
| 5141 | 4191 | 1.0000000 |
| TOTAL MCF METERED | 7442 | |

CONVERT TO THERMS (10.22 /MCF X NET MCF = 76,056 )

MONTHLY CUSTOMER CHARGE (BASED ON 93/12 USAGE OF 347,985 THERMS) $1,100.00

| | THERMS | CENTS/THM | AMOUNT |
|---|---|---|---|
| I-20 COMMODITY CHARGE | 76,056 | 6.950 | 5,285.89 |
| I-20 SEASONAL SUPPLY COST | 76,056 | 20.880 | 15,880.49 |
| BASE TAKE OR PAY COST | 76,056 | .000 | 0.00 |
| BASE ENVIRONMENTAL RESPONSE COST | 76,056 | .000 | 0.00 |
| SUB TOTAL | | | 22,266.38 |
| .00 % SALES TAX | | | 0.00 |
| TOTAL CURRENT AMOUNT | | | $22,266.38 |
| TOTAL CURRENT CHARGES | | | $22,266.38 |

Sue Rudd
14 Nov 94
Dennis Welling

A.5-43

REPORT ID: CMAM0051 521 - JESUP-WAYCROSS
RUN DATE : 11/10/94

ATLANTA GAS LIGHT COMPANY
INTERRUPTIBLE CUSTOMER WORKSHEET (THERMS)
ACCOUNT # 23558 0300 0 8



U S ARMY - FT. STEWART

OCTOBER

| | TOTAL VOLUMES METERED WITH BTU FACTOR OF 10.22 | I-20 INTERRUPTIBLE TOTAL USED | I-20 SEASONAL SUPPLY USED |
|---|---|---|---|
| 1 | 1,318 | 1,318 | 1,318 |
| 2 | 1,778 | 1,778 | 1,778 |
| 3 | 2,187 | 2,187 | 2,187 |
| 4 | 2,432 | 2,432 | 2,432 |
| 5 | 2,361 | 2,361 | 2,361 |
| 6 | 2,136 | 2,136 | 2,136 |
| 7 | 1,523 | 1,523 | 1,523 |
| 8 | 1,308 | 1,308 | 1,308 |
| 9 | 1,410 | 1,410 | 1,410 |
| 10 | 1,911 | 1,911 | 1,911 |
| 11 | 3,771 | 3,771 | 3,771 |
| 12 | 3,086 | 3,086 | 3,086 |
| 13 | 7,992 | 7,992 | 7,992 |
| 14 | 2,780 | 2,780 | 2,780 |
| 15 | 1,921 | 1,921 | 1,921 |
| 16 | 2,627 | 2,627 | 2,627 |
| 17 | 3,689 | 3,689 | 3,689 |
| 18 | 2,657 | 2,657 | 2,657 |
| 19 | 2,391 | 2,391 | 2,391 |
| 20 | 2,310 | 2,310 | 2,310 |
| 21 | 1,574 | 1,574 | 1,574 |
| 22 | 1,318 | 1,318 | 1,318 |
| 23 | 1,911 | 1,911 | 1,911 |
| 24 | 2,310 | 2,310 | 2,310 |
| 25 | 2,361 | 2,361 | 2,361 |
| 26 | 2,862 | 2,862 | 2,862 |
| 27 | 3,516 | 3,516 | 3,516 |
| 28 | 2,780 | 2,780 | 2,780 |
| 29 | 1,564 | 1,564 | 1,564 |
| 30 | 1,952 | 1,952 | 1,952 |
| 31 | 2,320 | 2,320 | 2,320 |
| DAILY TOTAL | 76,056 | 76,056 | 76,056 |
| EXCESS REALLOC | | | |
| GRAND TOTAL | 76,056 | 76,056 | 76,056 |

A.5-44

ATLANTA GAS LIGHT COMPANY - GEORGIA NATURAL GAS - SAVANNAH NATURAL GAS COMPANY
P.O.BOX 105256 ATLANTA, GA 30348-5256

INTERRUPTIBLE MONTHLY BILLING INVOICE NOVEMBER, 1994

U S ARMY - FT. STEWART
ARTILLERY FIRING CTR

ACCOUNT 23558-0300-0-8
I-20 COMMERCIAL RATE

DISTRICT 4630267

| METER NUMBER | USAGE | TEMPERATURE FACT. |
|---|---|---|
| 686 | 4710 | 1.0000000 |
| 5141 | 5805 | 1.0000000 |
| TOTAL MCF METERED | 10515 | |

CONVERT TO THERMS (10.23 /MCF X NET MCF = 107,571 )

MONTHLY CUSTOMER CHARGE (BASED ON 93/12 USAGE OF 347,985 THERMS) $1,100.00

| | THERMS | CENTS/THM | AMOUNT |
|---|---|---|---|
| I-20 COMMODITY CHARGE | 107,571 | 6.950 | 7,476.18 |
| I-20 SEASONAL SUPPLY COST | 107,571 | 23.540 | 25,322.21 |
| BASE TAKE OR PAY COST | 107,571 | .000 | 0.00 |
| BASE ENVIRONMENTAL RESPONSE COST | 107,571 | .000 | 0.00 |
| SUB TOTAL | | | 33,898.39 |
| .00 % SALES TAX | | | 0.00 |
| TOTAL CURRENT AMOUNT | | | $33,898.39 |
| TOTAL CURRENT CHARGES | | | $33,898.39 |

Svcs Rec'd
19 Nov 94
Denise Kelly

A.5-45

EPORT ID: CM[illegible]051 521 - JESUP-WAYCROSS
UN DATE : 12/09/94

U S ARMY - FT. STEWART

ATLANTA GAS LIGHT COMPANY
INTERRUPTIBLE CUSTOMER WORKSHEET (THERMS)
ACCOUNT # 23558 0300 0 8



NOVEMBER

| | TOTAL VOLUMES METERED WITH BTU FACTOR OF 10.23 | I-20 INTERRUPTIBLE TOTAL USED | I-20 SEASONAL SUPPLY USED |
|---|---|---|---|
| 1 | 3,509 | 3,509 | 3,509 |
| 2 | 5,115 | 5,115 | 5,115 |
| 3 | 3,253 | 3,253 | 3,253 |
| 4 | 3,212 | 3,212 | 3,212 |
| 5 | 2,189 | 2,189 | 2,189 |
| 6 | 2,660 | 2,660 | 2,660 |
| 7 | 3,325 | 3,325 | 3,325 |
| 8 | 2,813 | 2,813 | 2,813 |
| 9 | 2,639 | 2,639 | 2,639 |
| 10 | 4,123 | 4,123 | 4,123 |
| 11 | 4,941 | 4,941 | 4,941 |
| 12 | 2,885 | 2,885 | 2,885 |
| 13 | 2,558 | 2,558 | 2,558 |
| 14 | 3,192 | 3,192 | 3,192 |
| 15 | 2,926 | 2,926 | 2,926 |
| 16 | 3,683 | 3,683 | 3,683 |
| 17 | 4,338 | 4,338 | 4,338 |
| 18 | 2,742 | 2,742 | 2,742 |
| 19 | 2,486 | 2,486 | 2,486 |
| 20 | 2,926 | 2,926 | 2,926 |
| 21 | 3,079 | 3,079 | 3,079 |
| 22 | 3,632 | 3,632 | 3,632 |
| 23 | 5,545 | 5,545 | 5,545 |
| 24 | 5,759 | 5,759 | 5,759 |
| 25 | 4,164 | 4,164 | 4,164 |
| 26 | 4,051 | 4,051 | 4,051 |
| 27 | 2,926 | 2,926 | 2,926 |
| 28 | 3,049 | 3,049 | 3,049 |
| 29 | 3,570 | 3,570 | 3,570 |
| 30 | 6,281 | 6,281 | 6,281 |
| 31 | 0 | 0 | 0 |
| AILY TOTAL | 107,571 | 107,571 | 107,571 |
| XCESS REALLOC | | | |
| RAND TOTAL | 107,571 | 107,571 | 107,571 |

A.5-46

ATLANTA GAS LIGHT COMPANY - GEORGIA NATURAL GAS - SAVANNAH NATURAL GAS COMPANY
P.O.BOX 105256 ATLANTA, GA 30348-5256

INTERRUPTIBLE MONTHLY BILLING INVOICE DECEMBER, 1994

U S ARMY - FT. STEWART ACCOUNT 23558-0300-0-8 DISTRICT 4630267
ARTILLERY FIRING CTR I-20 COMMERCIAL RATE

| METER NUMBER | USAGE | TEMPERATURE FACT. |
|---|---|---|
| 686 | 8560 | 1.0000000 |
| 5141 | 10224 | 1.0000000 |
| TOTAL MCF METERED | 18784 | |

CONVERT TO THERMS (10.23 /MCF X NET MCF = 192,157 )

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MONTHLY CUSTOMER CHARGE (BASED ON 94/06 USAGE OF 310,484 THERMS) $1,100.00

| | THERMS | CENTS/THM | AMOUNT |
|---|---|---|---|
| I-20 COMMODITY CHARGE | 192,157 | 6.950 | 13,354.91 |
| I-20 SEASONAL SUPPLY COST | 192,157 | 23.700 | 45,541.21 |
| BASE TAKE OR PAY COST | 192,157 | .000 | 0.00 |
| BASE ENVIRONMENTAL RESPONSE COST | 192,157 | .000 | 0.00 |
| SUB TOTAL | | | 59,996.12 |
| .00 % SALES TAX | | | 0.00 |
| TOTAL CURRENT AMOUNT | | | $59,996.12 |
| TOTAL CURRENT CHARGES | | | $59,996.12 |

[illegible] 18 [illegible]

A.5-47

ATLANTA [illegible] LIGHT COMPANY
INTERRUPTIBLE CUSTOMER WORKSHEET (THERMS)
ACCOUNT # 23558 0300 0 8



U S ARMY - FT. STEWART

DECEMBER

| | TOTAL VOLUMES METERED WITH BTU FACTOR OF 10.23 | I-20 INTERRUPTIBLE TOTAL USED | I-20 SEASONAL SUPPLY USED |
|---|---|---|---|
| 1 | 7,202 | 7,202 | 7,202 |
| 2 | 4,348 | 4,348 | 4,348 |
| 3 | 2,803 | 2,803 | 2,803 |
| 4 | 3,355 | 3,355 | 3,355 |
| 5 | 3,734 | 3,734 | 3,734 |
| 6 | 3,396 | 3,396 | 3,396 |
| 7 | 3,816 | 3,816 | 3,816 |
| 8 | 3,724 | 3,724 | 3,724 |
| 9 | 3,171 | 3,171 | 3,171 |
| 10 | 2,639 | 2,639 | 2,639 |
| 11 | 6,731 | 6,731 | 6,731 |
| 12 | 9,043 | 9,043 | 9,043 |
| 13 | 8,961 | 8,961 | 8,961 |
| 14 | 7,785 | 7,785 | 7,785 |
| 15 | 6,731 | 6,731 | 6,731 |
| 16 | 6,997 | 6,997 | 6,997 |
| 17 | 5,759 | 5,759 | 5,759 |
| 18 | 6,711 | 6,711 | 6,711 |
| 19 | 9,299 | 9,299 | 9,299 |
| 20 | 7,079 | 7,079 | 7,079 |
| 21 | 9,555 | 9,555 | 9,555 |
| 22 | 10,660 | 10,660 | 10,660 |
| 23 | 8,378 | 8,378 | 8,378 |
| 24 | 7,683 | 7,683 | 7,683 |
| 25 | 5,309 | 5,309 | 5,309 |
| 26 | 6,118 | 6,118 | 6,118 |
| 27 | 7,069 | 7,069 | 7,069 |
| 28 | 6,230 | 6,230 | 6,230 |
| 29 | 4,685 | 4,685 | 4,685 |
| 30 | 7,478 | 7,478 | 7,478 |
| 31 | 5,708 | 5,708 | 5,708 |
| DAILY TOTAL | 192,157 | 192,157 | 192,157 |
| EXCESS REALLOC | - | | |
| GRAND TOTAL | 192,157 | 192,157 | 192,157 |

A.5-48

ATLANTA GAS LIGHT COMPANY - GEORGIA NATURAL GAS - SAVANNAH NATURAL GAS COMPANY
P.O.BOX 105256 ATLANTA, GA 30348-5256

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INTERRUPTIBLE MONTHLY BILLING INVOICE JANUARY, 1995

U S ARMY - FT. STEWART
ARTILLERY FIRING CTR

ACCOUNT 23558-0300-0-8
I-20 COMMERCIAL RATE

DISTRICT 4630267

| METER NUMBER | USAGE | TEMPERATURE FACT. |
|---|---|---|
| 686 | 10681 | 1.0000000 |
| 5141 | 12680 | 1.0000000 |
| TOTAL MCF METERED | 23361 | |

CONVERT TO THERMS (10.21 /MCF X NET MCF = 238,514 )

MONTHLY CUSTOMER CHARGE (BASED ON 94/06 USAGE OF 310,484 THERMS) $1,100.00

| | THERMS | CENTS/THM | AMOUNT |
|---|---|---|---|
| I-20 COMMODITY CHARGE | 238,514 | 6.950 | 16,576.72 |
| I-20 SEASONAL SUPPLY COST | 238,514 | 23.070 | 55,025.18 |
| BASE TAKE OR PAY COST | 238,514 | .000 | 0.00 |
| BASE ENVIRONMENTAL RESPONSE COST | 238,514 | .000 | 0.00 |
| SUB TOTAL | | | 72,701.90 |
| .00 % SALES TAX | | | 0.00 |
| TOTAL CURRENT AMOUNT | | | $72,701.90 |
| TOTAL CURRENT CHARGES | | | $72,701.90 |

Svcs Rec'd
17 Feb 95
Denise Kelley

A.5-49

EPORT ID: CMAM0051 521 - JESUP-WAYCROSS
JN DATE : 02/13/95

ATLANTA GAS LIGHT COMPANY
INTERRUPTIBLE CUSTOMER WORKSHEET (THERMS)
ACCOUNT # 23558 0300 0 8

U S ARMY - FT. STEWART

JANUARY

| | TOTAL VOLUMES METERED WITH BTU FACTOR OF 10.21 | I-20 INTERRUPTIBLE TOTAL USED | I-20 SEASONAL SUPPLY USED |
|---|---|---|---|
| 1 | 4,411 | 4,411 | 4,411 |
| 2 | 6,953 | 6,953 | 6,953 |
| 3 | 8,964 | 8,964 | 8,964 |
| 4 | 11,221 | 11,221 | 11,221 |
| 5 | 11,313 | 11,313 | 11,313 |
| 6 | 4,390 | 4,390 | 4,390 |
| 7 | 5,095 | 5,095 | 5,095 |
| 8 | 8,648 | 8,648 | 8,648 |
| 9 | 8,239 | 8,239 | 8,239 |
| 10 | 7,024 | 7,024 | 7,024 |
| 11 | 6,238 | 6,238 | 6,238 |
| 12 | 4,748 | 4,748 | 4,748 |
| 13 | 2,930 | 2,930 | 2,930 |
| 14 | 5,166 | 5,166 | 5,166 |
| 15 | 7,147 | 7,147 | 7,147 |
| 16 | 7,392 | 7,392 | 7,392 |
| 17 | 6,749 | 6,749 | 6,749 |
| 18 | 6,443 | 6,443 | 6,443 |
| 19 | 7,821 | 7,821 | 7,821 |
| 20 | 8,352 | 8,352 | 8,352 |
| 21 | 7,831 | 7,831 | 7,831 |
| 22 | 8,025 | 8,025 | 8,025 |
| 23 | 11,333 | 11,333 | 11,333 |
| 24 | 11,915 | 11,915 | 11,915 |
| 25 | 9,904 | 9,904 | 9,904 |
| 26 | 9,495 | 9,495 | 9,495 |
| 27 | 7,167 | 7,167 | 7,167 |
| 28 | 5,728 | 5,728 | 5,728 |
| 29 | 5,809 | 5,809 | 5,809 |
| 30 | 10,812 | 10,812 | 10,812 |
| 31 | 11,251 | 11,251 | 11,251 |
| AILY TOTAL | 238,514 | 238,514 | 238,514 |
| XCESS REALLOC | | | |
| RAND TOTAL | 238,514 | 238,514 | 238,514 |

A.5-50

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ATLANTA GAS LIGHT COMPANY - GEORGIA NATURAL GAS - SAVANNAH NATURAL GAS COMPANY
P.O.BOX 105256 ATLANTA, GA 30348-5256

INTERRUPTIBLE MONTHLY BILLING INVOICE FEBRUARY, 1995

U S ARMY - FT. STEWART
ARTILLERY FIRING CTR

ACCOUNT 23558-0300-0-8
I-20 COMMERCIAL RATE

DISTRICT 4530267

| METER NUMBER | USAGE | TEMPERATURE FACT. |
|---|---|---|
| 686 | 9591 | 1.0000000 |
| 5141 | 11318 | 1.0000000 |
| TOTAL MCF METERED | 20909 | |

CONVERT TO THERMS (10.23 /MCF X NET MCF = 213,897 )

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MONTHLY CUSTOMER CHARGE (BASED ON 94/06 USAGE OF 310,484 THERMS) $1,100.00

| | THERMS | CENTS/THM | AMOUNT |
|---|---|---|---|
| I-20 COMMODITY CHARGE | 213,897 | 6.950 | 14,865.84 |
| I-20 SEASONAL SUPPLY COST | 213,897 | 20.920 | 44,747.25 |
| BASE TAKE OR PAY COST | 213,897 | .000 | 0.00 |
| BASE ENVIRONMENTAL RESPONSE COST | 213,897 | .000 | 0.00 |
| SUB TOTAL | | | 60,713.09 |
| .00 % SALES TAX | | | 0.00 |
| TOTAL CURRENT AMOUNT | | | $60,713.09 |
| TOTAL CURRENT CHARGES | | | $60,713.09 |

Serv Rec'd
21 Mar 95
Denise Kelley

A.5-51

EPORT ID: CMAM0051 521 - JESUP-WAYCROSS
'UN DATE : 03/14/95

ATLANTA GAS LIGHT COMPANY
INTERRUPTIBLE CUSTOMER WORKSHEET (THERMS)
ACCOUNT # 23558 0300 0 8



U S ARMY - FT. STEWART

FEBRUARY

| | TOTAL VOLUMES METERED WITH BTU FACTOR OF 10.23 | I-20 INTERRUPTIBLE TOTAL USED | I-20 SEASONAL SUPPLY USED |
|---|---|---|---|
| 1 | 8,685 | 8,685 | 8,685 |
| 2 | 5,964 | 5,964 | 5,964 |
| 3 | 4,655 | 4,655 | 4,655 |
| 4 | 9,094 | 9,094 | 9,094 |
| 5 | 9,483 | 9,483 | 9,483 |
| 6 | 12,818 | 12,818 | 12,818 |
| 7 | 15,232 | 15,232 | 15,232 |
| 8 | 15,181 | 15,181 | 15,181 |
| 9 | 11,447 | 11,447 | 11,447 |
| 10 | 6,956 | 6,956 | 6,956 |
| 11 | 6,690 | 6,690 | 6,690 |
| 12 | 6,977 | 6,977 | 6,977 |
| 13 | 8,614 | 8,614 | 8,614 |
| 14 | 7,304 | 7,304 | 7,304 |
| 15 | 5,023 | 5,023 | 5,023 |
| 16 | 3,570 | 3,570 | 3,570 |
| 17 | 3,703 | 3,703 | 3,703 |
| 18 | 6,097 | 6,097 | 6,097 |
| 19 | 5,862 | 5,862 | 5,862 |
| 20 | 6,251 | 6,251 | 6,251 |
| 21 | 9,105 | 9,105 | 9,105 |
| 22 | 8,399 | 8,399 | 8,399 |
| 23 | 6,588 | 6,588 | 6,588 |
| 24 | 5,667 | 5,667 | 5,667 |
| 25 | 6,128 | 6,128 | 6,128 |
| 26 | 5,463 | 5,463 | 5,463 |
| 27 | 9,289 | 9,289 | 9,289 |
| 28 | 3,652 | 3,652 | 3,652 |
| 29 | 0 | 0 | 0 |
| 30 | 0 | 0 | 0 |
| 31 | 0 | 0 | 0 |
| 'AILY TOTAL | 213,897 | 213,897 | 213,897 |
| XCESS REALLOC | | | |
| 'RAND TOTAL | 213,897 | 213,897 | 213,897 |

A.5-52

ATLANTA GAS LIGHT COMPANY - GEORGIA NATURAL GAS - SAVANNAH NATURAL GAS COMPANY
P.O.BOX 105256 ATLANTA, GA 30348-5256

CMA

INTERRUPTIBLE MONTHLY BILLING INVOICE    MARCH, 1995

U S ARMY - FT. STEWART
ARTILLERY FIRING CTR

ACCOUNT 23558-0300-0-8
I-20 COMMERCIAL RATE

DISTRICT 4530267

| METER NUMBER | USAGE | TEMPERATURE FACT. |
|---|---|---|
| 686 | 7176 | 1.0000000 |
| 5141 | 8484 | 1.0000000 |

TOTAL MCF METERED 15660

CONVERT TO THERMS (10.21 /MCF X NET MCF = 159,888 )

---

MONTHLY CUSTOMER CHARGE (BASED ON 94/06 USAGE OF 310,484 THERMS) $1,100.00

| | THERMS | CENTS/THM | AMOUNT |
|---|---|---|---|
| I-20 COMMODITY CHARGE | 159,888 | 6.950 | 11,112.22 |
| I-20 SEASONAL SUPPLY COST | 159,888 | 19.980 | 31,945.62 |
| BASE TAKE OR PAY COST | 159,888 | .000 | 0.00 |
| BASE ENVIRONMENTAL RESPONSE COST | 159,888 | .000 | 0.00 |
| SUB TOTAL | | | 44,157.84 |
| .00 % SALES TAX | | | 0.00 |
| TOTAL CURRENT AMOUNT | | | $44,157.84 |
| TOTAL CURRENT CHARGES | | | $44,157.84 |

Rec'd
18 Apr 95
Denise Keller

A.5-53

EPORT ID: CMAH0051 521 - JESUP-WAYCROSS
UN DATE : 04/11/95

ATLANTA GAS LIGHT COMPANY
INTERRUPTIBLE CUSTOMER WORKSHEET (THERMS)
ACCOUNT # 23558 0300 0 8



U S ARMY - FT. STEWART

MARCH

| | TOTAL VOLUMES METERED WITH BTU FACTOR OF 10.21 | I-20 INTERRUPTIBLE TOTAL USED | I-20 SEASONAL SUPPLY USED |
|---|---|---|---|
| 1 | 4,421 | 4,421 | 4,421 |
| 2 | 5,901 | 5,901 | 5,901 |
| 3 | 4,993 | 4,993 | 4,993 |
| 4 | 4,717 | 4,717 | 4,717 |
| 5 | 5,922 | 5,922 | 5,922 |
| 6 | 4,482 | 4,482 | 4,482 |
| 7 | 4,115 | 4,115 | 4,115 |
| 8 | 6,003 | 6,003 | 6,003 |
| 9 | 10,169 | 10,169 | 10,169 |
| 10 | 11,313 | 11,313 | 11,313 |
| 11 | 5,758 | 5,758 | 5,758 |
| 12 | 4,809 | 4,809 | 4,809 |
| 13 | 4,727 | 4,727 | 4,727 |
| 14 | 4,799 | 4,799 | 4,799 |
| 15 | 4,104 | 4,104 | 4,104 |
| 16 | 4,574 | 4,574 | 4,574 |
| 17 | 3,655 | 3,655 | 3,655 |
| 18 | 4,390 | 4,390 | 4,390 |
| 19 | 5,381 | 5,381 | 5,381 |
| 20 | 4,625 | 4,625 | 4,625 |
| 21 | 4,462 | 4,462 | 4,462 |
| 22 | 4,809 | 4,809 | 4,809 |
| 23 | 4,809 | 4,809 | 4,809 |
| 24 | 4,492 | 4,492 | 4,492 |
| 25 | 4,390 | 4,390 | 4,390 |
| 26 | 5,381 | 5,381 | 5,381 |
| 27 | 4,625 | 4,625 | 4,625 |
| 28 | 4,462 | 4,462 | 4,462 |
| 29 | 4,809 | 4,809 | 4,809 |
| 30 | 4,809 | 4,809 | 4,809 |
| 31 | 3,982 | 3,982 | 3,982 |
| AILY TOTAL | 159,888 | 159,888 | 159,888 |
| XCESS REALLOC | | | |
| RAND TOTAL | 159,888 | 159,888 | 159,888 |

A.5-54

.ıLANTA GAS LIGHT COMPANY - GEORGIA NATURAL GAS - SAVANNAH NATURAL GAS COMPANY
P.O.BOX 105256 ATLANTA, GA 30348-5256

CMA

INTERRUPTIBLE MONTHLY BILLING INVOICE APRIL, 1995

U S ARMY - FT. STEWART
ARTILLERY FIRING CTR

ACCOUNT 23558-0300-0-8
I-20 COMMERCIAL RATE

DISTRICT 4530267

| METER NUMBER | USAGE | TEMPERATURE FACT. |
|---|---|---|
| 686 | 10595 | 1.0000000 |
| 5141 | 13917 | 1.0000000 |
| TOTAL MCF METERED | 24512 | |

CONVERT TO THERMS (10.21 /MCF X NET MCF = 250,269 )

MONTHLY CUSTOMER CHARGE (BASED ON 94/06 USAGE OF 310,484 THERMS) $1,100.00

| | THERMS | CENTS/THM | AMOUNT |
|---|---|---|---|
| I-20 COMMODITY CHARGE | 250,269 | 6.950 | 17,393.70 |
| I-20 SEASONAL SUPPLY COST | 250,269 | 20.840 | 52,156.06 |
| BASE TAKE OR PAY COST | 250,000 | .000 | 0.00 |
| EXCESS TAKE OR PAY COST | 269 | .000 | 0.00 |
| BASE ENVIRONMENTAL RESPONSE COST | 250,000 | .000 | 0.00 |
| EXCESS ENVIRONMENTAL RESPONSE COST | 269 | .000 | 0.00 |
| SUB TOTAL | | | 70,649.76 |
| .00 % SALES TAX | | | 0.00 |
| TOTAL CURRENT AMOUNT | | | $70,649.76 |
| TOTAL CURRENT CHARGES | | | $70,649.76 |

Swindell
18 May 95
Denise Kelley

A.5-55

REPORT ID: CMAM0051 521 - JESUP-WAYCROSS
RUN DATE : 05/09/95

ATLANTA GAS LIGHT COMPANY
INTERRUPTIBLE CUSTOMER WORKSHEET (THERMS)
ACCOUNT # 23558 0300 0 8



U S ARMY - FT. STEWART

APRIL

| | TOTAL VOLUMES METERED WITH BTU FACTOR OF 10.21 | I-20 INTERRUPTIBLE TOTAL USED | I-20 SEASONAL SUPPLY USED |
|---|---|---|---|
| 1 | 13,610 | 13,610 | 13,610 |
| 2 | 13,610 | 13,610 | 13,610 |
| 3 | 13,610 | 13,610 | 13,610 |
| 4 | 13,610 | 13,610 | 13,610 |
| 5 | 13,610 | 13,610 | 13,610 |
| 6 | 14,008 | 14,008 | 14,008 |
| 7 | 14,223 | 14,223 | 14,223 |
| 8 | 14,365 | 14,365 | 14,365 |
| 9 | 16,407 | 16,407 | 16,407 |
| 10 | 14,468 | 14,468 | 14,468 |
| 11 | 12,763 | 12,763 | 12,763 |
| 12 | 12,783 | 12,783 | 12,783 |
| 13 | 13,018 | 13,018 | 13,018 |
| 14 | 12,375 | 12,375 | 12,375 |
| 15 | 11,731 | 11,731 | 11,731 |
| 16 | 12,038 | 12,038 | 12,038 |
| 17 | 4,880 | 4,880 | 4,880 |
| 18 | 2,553 | 2,553 | 2,553 |
| 19 | 2,461 | 2,461 | 2,461 |
| 20 | 2,226 | 2,226 | 2,226 |
| 21 | 1,725 | 1,725 | 1,725 |
| 22 | 1,358 | 1,358 | 1,358 |
| 23 | 2,011 | 2,011 | 2,011 |
| 24 | 3,043 | 3,043 | 3,043 |
| 25 | 3,339 | 3,339 | 3,339 |
| 26 | 2,746 | 2,746 | 2,746 |
| 27 | 2,491 | 2,491 | 2,491 |
| 28 | 1,899 | 1,899 | 1,899 |
| 29 | 1,399 | 1,399 | 1,399 |
| 30 | 1,909 | 1,909 | 1,909 |
| 31 | 0 | 0 | 0 |
| DAILY TOTAL | 250,269 | 250,269 | 250,269 |
| EXCESS REALLOC | | | |
| GRAND TOTAL | 250,269 | 250,269 | 250,269 |

A.5-56

ATLANTA GAS LIGHT COMPANY - GEORGIA NATURAL GAS - SAVANNAH NATURAL GAS COMPANY
P.O.BOX 105256 ATLANTA, GA 30348-5256

INTERRUPTIBLE MONTHLY BILLING INVOICE        MAY, 1995

U S ARMY - FT. STEWART        ACCOUNT 23558-0300-0-8        DISTRICT 4530267
ARTILLERY FIRING CTR        I-20 COMMERCIAL RATE

| METER NUMBER | USAGE | TEMPERATURE FACT. |
|---|---|---|
| 686 | 3038 | 1.0000000 |
| 5141 | 3586 | 1.0000000 |
| TOTAL MCF METERED | 6624 | |

CONVERT TO THERMS (10.24 /MCF X NET MCF = 67,830 )

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MONTHLY CUSTOMER CHARGE (BASED ON 94/06 USAGE OF 310,484 THERMS) $1,100.00

| | THERMS | CENTS/THM | AMOUNT |
|---|---|---|---|
| I-20 COMMODITY CHARGE | 67,830 | 6.950 | 4,714.19 |
| I-20 SEASONAL SUPPLY COST | 67,830 | 21.990 | 14,915.82 |
| BYPASS RECOVERY FACTOR | 67,830 | .050 | 33.92 |
| SUB TOTAL | | | 20,763.93 |
| .00 % SALES TAX | | | 0.00 |
| TOTAL CURRENT AMOUNT | | | $20,763.93 |
| TOTAL CURRENT CHARGES | | | $20,763.93 |

Svcs Rec'd
19 Jun 95

REPORT ID: CMAM0051 521 - JESUP-WAYCROSS
RUN DATE : 06/09/95

ATLANTA GAS LIGHT COMPANY
INTERRUPTIBLE CUSTOMER WORKSHEET (THERMS)
ACCOUNT # 23558 0300 0 8



U S ARMY - FT. STEWART

MAY

| | TOTAL VOLUMES METERED WITH BTU FACTOR OF 10.24 | I-20 INTERRUPTIBLE TOTAL USED | I-20 SEASONAL SUPPLY USED |
|---|---|---|---|
| 1 | 2,314 | 2,314 | 2,314 |
| 2 | 2,509 | 2,509 | 2,509 |
| 3 | 2,509 | 2,509 | 2,509 |
| 4 | 2,284 | 2,284 | 2,284 |
| 5 | 1,669 | 1,669 | 1,669 |
| 6 | 1,413 | 1,413 | 1,413 |
| 7 | 2,314 | 2,314 | 2,314 |
| 8 | 3,205 | 3,205 | 3,205 |
| 9 | 2,109 | 2,109 | 2,109 |
| 10 | 2,109 | 2,109 | 2,109 |
| 11 | 2,386 | 2,386 | 2,386 |
| 12 | 1,792 | 1,792 | 1,792 |
| 13 | 1,280 | 1,280 | 1,280 |
| 14 | 2,028 | 2,028 | 2,028 |
| 15 | 2,468 | 2,468 | 2,468 |
| 16 | 2,294 | 2,294 | 2,294 |
| 17 | 2,273 | 2,273 | 2,273 |
| 18 | 2,314 | 2,314 | 2,314 |
| 19 | 1,853 | 1,853 | 1,853 |
| 20 | 1,710 | 1,710 | 1,710 |
| 21 | 2,099 | 2,099 | 2,099 |
| 22 | 2,468 | 2,468 | 2,468 |
| 23 | 2,601 | 2,601 | 2,601 |
| 24 | 2,376 | 2,376 | 2,376 |
| 25 | 2,376 | 2,376 | 2,376 |
| 26 | 1,987 | 1,987 | 1,987 |
| 27 | 1,751 | 1,751 | 1,751 |
| 28 | 1,731 | 1,731 | 1,731 |
| 29 | 2,365 | 2,365 | 2,365 |
| 30 | 2,601 | 2,601 | 2,601 |
| 31 | 2,642 | 2,642 | 2,642 |
| DAILY TOTAL | 67,830 | 67,830 | 67,830 |
| EXCESS REALLOC | | | |
| GRAND TOTAL | 67,830 | 67,830 | 67,830 |

A.5-58

ATLANTA GAS LIGHT COMPANY - GEORGIA NATURAL GAS - SAVANNAH NATURAL GAS COMPANY
P.O.BOX 105256 ATLANTA, GA 30348-5256

INTERRUPTIBLE MONTHLY BILLING INVOICE JUNE, 1995

U S ARMY - FT. STEWART
ARTILLERY FIRING CTR

ACCOUNT 23558-0300-0-8
I-20 COMMERCIAL RATE

DISTRICT 4530267

| METER NUMBER | USAGE | TEMPERATURE FACT. |
|---|---|---|
| 686 | 4548 | 1.0000000 |
| 5141 | 5173 | 1.0000000 |
| TOTAL MCF METERED | 9721 | |

CONVERT TO THERMS (10.22 /MCF X NET MCF = 99,348 )

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MONTHLY CUSTOMER CHARGE (BASED ON 95/04 USAGE OF 250,269 THERMS) $1,100.00

| | THERMS | CENTS/THM | AMOUNT |
|---|---|---|---|
| I-20 COMMODITY CHARGE | 99,348 | 6.950 | 6,904.69 |
| I-20 SEASONAL SUPPLY COST | 99,348 | 22.140 | 21,995.65 |
| BYPASS RECOVERY FACTOR | 99,348 | .050 | 49.67 |
| SUB TOTAL | | | 30,050.01 |
| .00 % SALES TAX | | | 0.00 |
| TOTAL CURRENT AMOUNT | | | $30,050.01 |
| TOTAL CURRENT CHARGES | | | $30,050.01 |

A.5-59

REPORT ID: CMAM0051 521 - JESUP-WAYCROSS
RUN DATE : 07/10/95

ATLANTA GAS LIGHT COMPANY
INTERRUPTIBLE CUSTOMER WORKSHEET (THERMS)
ACCOUNT # 23558 0300 0 8



U S ARMY - FT. STEWART

JUNE

| | TOTAL VOLUMES METERED WITH BTU FACTOR OF 10.22 | I-20 INTERRUPTIBLE TOTAL USED | I-20 SEASONAL SUPPLY USED |
|---|---|---|---|
| 1 | 2,473 | 2,473 | 2,473 |
| 2 | 2,085 | 2,085 | 2,085 |
| 3 | 1,758 | 1,758 | 1,758 |
| 4 | 3,178 | 3,178 | 3,178 |
| 5 | 8,953 | 8,953 | 8,953 |
| 6 | 3,260 | 3,260 | 3,260 |
| 7 | 2,494 | 2,494 | 2,494 |
| 8 | 2,269 | 2,269 | 2,269 |
| 9 | 1,983 | 1,983 | 1,983 |
| 10 | 1,543 | 1,543 | 1,543 |
| 11 | 2,667 | 2,667 | 2,667 |
| 12 | 12,826 | 12,826 | 12,826 |
| 13 | 4,527 | 4,527 | 4,527 |
| 14 | 2,167 | 2,167 | 2,167 |
| 15 | 2,279 | 2,279 | 2,279 |
| 16 | 1,983 | 1,983 | 1,983 |
| 17 | 1,533 | 1,533 | 1,533 |
| 18 | 2,156 | 2,156 | 2,156 |
| 19 | 2,514 | 2,514 | 2,514 |
| 20 | 2,340 | 2,340 | 2,340 |
| 21 | 2,126 | 2,126 | 2,126 |
| 22 | 2,310 | 2,310 | 2,310 |
| 23 | 1,574 | 1,574 | 1,574 |
| 24 | 1,502 | 1,502 | 1,502 |
| 25 | 1,789 | 1,789 | 1,789 |
| 26 | 2,300 | 2,300 | 2,300 |
| 27 | 2,289 | 2,289 | 2,289 |
| 28 | 2,064 | 2,064 | 2,064 |
| 29 | 4,946 | 4,946 | 4,946 |
| 30 | 13,460 | 13,460 | 13,460 |
| 31 | 0 | 0 | 0 |
| DAILY TOTAL | 99,348 | 99,348 | 99,348 |
| EXCESS REALLOC | | | |
| GRAND TOTAL | 99,348 | 99,348 | 99,348 |

A.5-60

# BOILER LOGS

A.5-62

# FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CENTRAL ENERGY PLANT | BLDG. NO. 1412 | MONTH: DECEMBER 1996

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 1 1,000 LB. (2) | BOILER 2 1,000 LB. (3) | BOILER #4 1,000 LB. (4) | TOTAL 1,000 LB. (5) | WOOD TONS 1,000 LB. (6) | #2 FUEL USED GAL. * (7) | NAT GAS CU. FT. (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. (10) | TEMP. °F. (11) | MAKEUP GAL. (12) | %CO2 BOILER 1 (13) | BOILER 2 (14) | #4 (15) | FLUE GAS TEMPERATURE BOILER 1 °F. (16) | 2 °F. (17) | #4 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | (22) | CHILL WATER m/u (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 200 | | | 1532 | 1532 | 202 | 505 | 23470 | 49 | | | 7430 | | | 7.2 | | | 420 | 380 | 6 | EF | | 5600 |
| 2 | 200 | | | 1506 | 1506 | 207 | 326 | 13060 | 53 | | | 9300 | | | 7.2 | | | 420 | 380 | 6 | CP | | 4100 |
| 3 | 200 | | | 1491 | 1491 | 197 | 477 | 5420 | 54 | | | 10090 | | | 7.2 | | | 420 | 380 | 6 | EF | | 5100 |
| 4 | 200 | | | 1427 | 1427 | 196 | 313 | 37120 | 58 | | | 8930 | | | 7.2 | | | 420 | 380 | 6 | CP | | 5700 |
| 5 | 200 | | | 1393 | 1393 | 189 | 570 | 14370 | 66 | | | 9170 | | | 7.2 | | | 420 | 380 | 6 | RP | | 6100 |
| 6 | 200 | | | 1341 | 1341 | 100 | 581 | 15700 | 60 | | | 6600 | | | 7.6 | | | 450 | 378 | 6 | UB | | 6500 |
| 7 | 200 | | | 1419 | 1419 | 195 | 255 | 9710 | 53 | | | 9930 | | | 7.6 | | | 450 | 378 | 6 | DR | | 6000 |
| 8 | 200 | | | 1673 | 1673 | 217 | 320 | 15920 | 42 | | | 7770 | | | 7.5 | | | 450 | 378 | 6 | CP | | 2800 |
| 9 | 200 | | | 1717 | 1717 | 233 | 596 | 6820 | 44 | | | 7430 | | | 7.4 | | | 450 | 380 | 6 | EF | | 3200 |
| 10 | 200 | | | 1830 | 1830 | 249 | 560 | 12910 | 32 | | | 9410 | | | 7.5 | | | 450 | 380 | 6 | CP | | 2600 |
| 11 | 200 | | | 1890 | 1890 | 254 | 388 | 37390 | 33 | | | 9100 | | | 7.0 | | | 450 | 380 | 6 | EF | | 3000 |
| 12 | 200 | | 62 | 1876 | 1938 | 252 | 360 | 9430 | 39 | | | 8010 | | 7.2 | 7.0 | | | 450 | 380 | 6 | CP | | 1950 |
| 13 | 200 | | | 1705 | 1705 | 228 | 393 | 110 | 46 | | | 9780 | | | 6.0 | | | 450 | 380 | 6 | RP | | 2950 |
| 14 | 200 | | | 1497 | 1497 | 206 | 288 | 2130 | 57 | | | 9470 | | | 6.0 | | | 450 | 380 | 6 | DR | | 4300 |
| 15 | 200 | | | 1312 | 1312 | 176 | 290 | 260 | 63 | | | 10930 | | | 6.0 | | | 450 | 380 | 6 | EF | | 4300 |
| 16 | 200 | | | 1340 | 1340 | 183 | 332 | 3350 | 66 | | | 8650 | | | 6.0 | | | 450 | 380 | 6 | CP | | 2100 |
| 17 | 200 | | | 1390 | 1390 | 190 | 315 | 70 | 56 | | | 9770 | | | 6.0 | | | 450 | 380 | 6 | EF | | 2700 |
| 18 | 200 | | | 1459 | 1459 | 201 | 555 | 50 | 55 | | | 8500 | | | 6.5 | | | 450 | 380 | 6 | CP | | 2100 |
| 19 | 200 | | | 1406 | 1406 | 187 | 346 | 50 | 63 | | | 6790 | | | 6.5 | | | 450 | 380 | 6 | EF | | 1800 |
| 20 | 200 | | | 1565 | 1565 | 210 | 303 | 2760 | 46 | | | 7300 | | | 6.5 | | | 450 | 380 | 6 | RP | | 1300 |
| 21 | 200 | | | 1872 | 1872 | 254 | 306 | 30 | 37 | | | 7620 | | | 6.5 | | | 450 | 380 | 6 | DR | | 2200 |
| 22 | 200 | | | 1894 | 1894 | 261 | 315 | 100 | 36 | | | 4410 | | | 6.6 | | | 450 | 380 | 6 | CP | | 800 |
| 23 | 200 | | | 1846 | 1846 | 249 | 181 | 4760 | 37 | | | 6220 | | | 6.5 | | | 450 | 380 | 6 | EF | | 1700 |
| 24 | 200 | | | 1935 | 1935 | 254 | 674 | 70 | 31 | | | 7180 | | | 6.5 | | | 450 | 380 | 6 | CP | | 1900 |
| 25 | 200 | | | 1929 | 1929 | 264 | 180 | 30 | 33 | | | 4420 | | | 6.5 | | | 450 | 380 | 6 | EF | | 1300 |
| 26 | 200 | | | 1963 | 1963 | 251 | 1074 | 30 | 33 | | | 5050 | | | 6.5 | | | 450 | 380 | 6 | DR | | 1600 |
| 27 | 200 | | | 1802 | 1802 | 205 | 2504 | 1560 | 37 | | | 7010 | | | 6.4 | | | 450 | 376 | 6 | WB | | 1600 |
| 28 | 200 | | | 1808 | 1808 | 200 | 2918 | 110 | 34 | | | 9310 | | | 6.4 | | | 450 | 375 | 6 | PR | | 1800 |
| 29 | 200 | | | 1850 | 1850 | 206 | 2846 | 50 | 36 | | | 10690 | | | 6.5 | | | 450 | 375 | 6 | EF | | 2800 |
| 30 | 200 | | | 1703 | 1703 | 216 | 1102 | -0- | 49 | | | 11030 | | | 7.0 | | | 450 | 375 | 6 | CP | | 2300 |
| 31 | 200 | | | 1528 | 1528 | 193 | 1030 | 90 | 55 | | | 12610 | | | 6.5 | | | 450 | 375 | 6 | EF | | 4800 |
| TOTAL | 6200 | | 62 | 50899 | 50961 | 6625 | 21203 | 216880 | 1453 | | | 259510 | | 7.2 | 209 | | | 13800 | 11740 | 186 | | | 97,000 |
| MAXIMUM | 200 | | 62 | 1963 | 1963 | 264 | 2918 | 37390 | 66 | | | 12610 | | 7.2 | 7.6 | | | 450 | 380 | 6 | | | 6500 |
| MINIMUM | 200 | | 62 | 1312 | 1312 | 100 | 180 | 30 | 31 | | | 4110 | | 7.2 | 6.0 | | | 420 | 375 | 6 | | | 800 |
| AVERAGE | 200 | | 62 | 1642 | 1644 | 214 | 683 | 6996 | 47 | | | 8371 | | 7.2 | 6.7 | | | 445 | 378 | 6 | | | 3129 |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 2395; OIL: 118; NAT GAS: 8944

REMARKS: * No 2 OIL: 9709; RECLAIMED OIL F.S.: 11,494

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: Rodney A. Phillips | DATE: 14 Jan 96 | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 568, 1 JUN 58, WHICH WILL BE USED.

A.5-63

# FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CEP | BLDG. No: 1412 | MONTH: NOV 95

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 2 1,000 LB. (2) | BOILER 3 1,000 LB. (3) | BOILER 3/4 1,000 LB. (4) | TOTAL 1,000 LB. (5) | WARD WATER TONS 1,000 LB. (6) | #2 FUEL USED GAL. (7) | N.G. EVAP. LB. PER UNIT (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. W.O. (10) | FEEDWATER HEATER TEMP. °F. (11) | MAKEUP GAL. (12) | %CO2 BOILER 1 (13) | %CO2 BOILER 2 (14) | %CO2 BOILER 3/4 (15) | FLUE GAS TEMPERATURE BOILER 1 °F. (16) | FLUE GAS TEMP. BOILER 2 °F. (17) | FLUE GAS TEMP. BOILER 3/4 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | #4 O/S (22) | CWMU (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 200 | ( | 616 | | 1232 | — | — | 763,201 | 67 | — | | 4020 | | 7.1 | | | 450 | 450 | 377 | 0 | D.T | 0 | 1100 |
| 2 | 200 | | 200 | 647 | 847 | | | 555800 | 74 | | | 5090 | | 7.1 | 7.1 | | 450 | 450 | 378 | 0 | DM | | 500 |
| 3 | 200 | | | 864 | 864 | — | — | 638190 | 71 | - | | 3730 | | | 7.1 | | | 450 | 379 | 0 | RS | 0 | 200 |
| 4 | 200 | | | 880 | 880 | | | 614510 | 55 | — | | 7330 | | | | | | | 380 | 0 | W | — | 200 |
| 5 | 200 | | | 846 | 846 | | | 608980 | 45 | — | | 2280 | | | | | | | 380 | 0 | Dn | | 100 |
| 6 | 200 | 54 | | 877 | 931 | | | 697630 | 52 | · | | 7650 | | | | | | | 380 | 0 | Dn | | 100 |
| 7 | 200 | | 96 | 912 | 1007 | | | 679460 | 66 | - | | 2440 | | | 7.1 | | | 450 | 380 | 0 | DT | | 1200 |
| 8 | 200 | | 212 | 800 | 1012 | | | 806800 | 54 | — | | 3700 | | 7.1 | 7.1 | | 450 | 450 | 380 | 0 | DM | | 800 |
| 9 | 200 | | 120 | 869 | 989 | — | - | 502700 | 45 | — | | 9110 | | 7.1 | 7.1 | | 450 | 450 | 380 | 0 | RP | 0 | 1500 |
| 10 | 200 | | 340 | 803 | 1143 | | #4 452 | 872100 | 52 | - | | 10140 | | 7.1 | 7.1 | | 450 | 450 | 380 | 0 | RP | 0 | 2500 |
| 11 | 200 | | 135 | 456 | 602 | 1193 | 52 | 1690 | 439980 | 64 | - | | 5410 | | — | — | | — | — | 378 | 6 | W | 223 | 1800 |
| 12 | 200 | | | | 1348 | 1348 | 186 | 8 | 7630 | 42 | - | | 6830 | | | | | | | 380 | 6 | W | 1 | 1900 |
| 13 | 200 | | | | 1361 | 1361 | 187 | 0 | 13,820 | 47 | — | | 10,000 | | | 7.0 | | | 420 | 380 | 6 | RP | 0 | 3300 |
| 14 | 200 | | | | 1377 | 1377 | 188 | 66 | 13490 | 49 | | | 9320 | | | — | | | — | 377 | 6 | W | 9 | 1800 |
| 15 | 200 | | | | 1619 | 1619 | 214 | 0 | 7800 | 44 | 516 | | 12200 | Warming up 3001 | | | | | 430 | 378 | 6 | Z | 63 | 2400 |
| 16 | 200 | | | | 1661 | 1661 | 211 | — | 5416 | 42 | 1050 | | 13,450 | " | " | " | | | | 377 | 6 | DT | 129 | 4000 |
| 17 | 200 | | | | 1647 | 1647 | 209 | — | 20080 | 45 | 1067 | | 16220 | " | " | " | | | | 377 | 6 | RP | 131 | 5500 |
| 18 | 200 | | | | 1579 | 1579 | 190 | — | 8730 | 49 | 1614 | | 14560 | OFF | " | " | | | | 378 | 6 | W | 198 | 3200 |
| 19 | 200 | | | | 1410 | 1410 | 170 | — | 13480 | 55 | 1430 | | 10130 | off | " | " | | | | 377 | 6 | RP | 176 | 4500 |
| 20 | 200 | | | | 1415 | 1415 | 165 | — | 15080 | 55 | 1755 | | 13380 | | " | " | | | | 377 | 6 | RP | 215 | 7100 |
| 21 | 200 | | | | 1418 | 1418 | 185 | — | 15030 | 57 | 172 | | 14530 | | | | | | | 378 | 6 | RP | 21 | 9300 |
| 22 | 200 | | | | 1586 | 1586 | 192 | — | 3066 | 44 | 1510 | | 14460 | | | | | | | 378 | 6 | RS | 185 | 6,200 |
| 23 | 200 | | | | 1642 | 1642 | 179 | | 16200 | 46 | 2748 | | 10020 | | | | | | | 378 | 6 | DM | 337 | 4,400 |
| 24 | 200 | | | | 1593 | 1593 | 190 | | 10820 | 51° | 1765 | | 7950 | | | | | | | 378 | 6 | Dn | 217 | 4600 |
| 25 | 200 | | | | 1626 | 1626 | 203 | 1140 | 9910 | 43 | — | | 11720 | | | | | | | [illegible] | 6 | D.T | 166 | 4,100 |
| 26 | 200 | | | | 1666 | 1666 | 207 | 1264 | 15030 | 47 | — | | 4,100 | | | | | | | [illegible] | 6 | D.T | 166 | 4,100 |
| 27 | 200 | | | | 1602 | 1602 | 215 | 285 | 15810 | 52° | — | | 9450 | | | | | | | 378 | 6 | Dn | 38 | 3500 |
| 28 | 200 | | | | 1453 | 1453 | 192 | 430 | 15,230 | 65 | — | | 10070 | | | | | | | 378 | 6 | E.Z. | 56 | 8100 |
| 29 | 200 | | | | 1310 | 1310 | 177 | 208 | 24410 | 60 | — | | 9450 | | | | | | | 378 | 6 | Dn | 27 | 9800 |
| 30 | 200 | | | | 1581 | 1581 | 217 | 44 | 11390 | 47 | — | | 7410 | | | | | | | 377 | 6 | DT | 6 | 5700 |
| 31 | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | | 261230 | | | | | | | | | | | |
| MAXIMUM | | | | | | | | | | | | | | | | | | | | | | | |
| MINIMUM | | | | | | | | | | | | | | | | | | | | | | | |
| AVERAGE | | | | | | | | | | | | | | | | | | | | | | | |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM ... WHICH WILL BE USED

A.5-64

# FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CENTRAL ENERGY PLANT | BLDG. NO. 1412 | MONTH: OCTOBER 1995

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 1 1,000 LB. (2) | BOILER 2 1,000 LB. (3) | BOILER 3/4 1,000 LB. (4) | TOTAL 1,000 LB. (5) | WOOD TONS (6) | Nº2 OIL FUEL USED GAL. * (7) | NAT GAS EVAP. LB. PER UNIT (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. (10) | FEEDWATER HEATER TEMP. °F. (11) | MAKEUP GAL. (12) | %CO2 BOILER 1 (13) | %CO2 BOILER 2 (14) | %CO2 BOILER 3/4 (15) | FLUE GAS TEMP. BOILER 1 °F. (16) | FLUE GAS TEMP. BOILER 2 °F. (17) | FLUE GAS TEMP. BOILER 3/4 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | (22) | CHILL WATER M/U (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 200 | | | 1544 | 1544 | 203 | 370 | 12860 | 71 | | | 4280 | | | 6.0 | | | 465 | 375 | 6 | EF | | 2740 |
| 2 | 200 | | | 1513 | 1513 | 209 | 354 | 12050 | 72 | | | 4230 | | | 6.0 | | | 466 | 376 | 6 | EB | | 3460 |
| 3 | 200 | | | 1647 | 1647 | 207 | 212 | 11160 | 74 | | | 6570 | | | 6.0 | | | 465 | 377 | 6 | EB | | 2900 |
| 4 | 200 | | | 1838 | 1838 | 208 | 867 | 15380 | 81 | | | 6580 | | | 6.0 | | | 465 | 376 | 6 | DR | | 2600 |
| 5 | 200 | | | 1886 | 1886 | 200 | 915 | 10430 | 78 | | | 6180 | | | 6.0 | | | 465 | 376 | 6 | DR | | 2000 |
| 6 | 200 | | | 1773 | 1773 | 204 | 507 | 25400 | 83 | | | 5740 | | | 6.0 | | | 465 | 376 | 6 | EF | | 1800 |
| 7 | 200 | | | 1823 | 1823 | 201 | 775 | 19430 | 77 | | | 7050 | | | 6.0 | | | 465 | 377 | 6 | EF | | 2300 |
| 8 | 200 | | | 1830 | 1830 | 202 | 285 | 14200 | 70 | | | 6500 | | | 6.0 | | | 465 | 376 | 6 | EF | | 1700 |
| 9 | 200 | | | 1787 | 1787 | 207 | 390 | 14570 | 70 | | | 14570 | | | 6.0 | | | 465 | 377 | 6 | DT | | 1700 |
| 10 | 200 | | | 1983 | 1983 | 200 | 559 | 10130 | 69 | | | 10080 | | | 6.0 | | | 465 | 376 | 6 | EG | | 2800 |
| 11 | 200 | | | 1813 | 1813 | 200 | 918 | 10860 | 70 | | | 12230 | | | 6.0 | | | 465 | 375 | 6 | EB | | 3400 |
| 12 | 200 | | | 1760 | 1760 | 202 | 321 | 29590 | 68 | | | 6710 | | | 6.0 | | | 465 | 375 | 6 | DR | | 2300 |
| 13 | 200 | | | 1861 | 1861 | 207 | 270 | 20570 | 75 | | | 7390 | | | 6.0 | | | 465 | 375 | 6 | EF | | 2900 |
| 14 | 200 | 120/128 | 60 | 1419 | 1719 | 100 | 319 | 170730 | 75 | | | 1110 | 7.0 | 7.0 | 6.0 | 465 | 465 | 465 | 377 | 6 | WB | | 2900 |
| 15 | 200 | | 708 | 3/739 | 1447 | | | 276300 | 62 | | | 7610 | | 7.0 | 6.0 | | 465 | 465 | 376 | | RP | | 2400 |
| 16 | 200 | | 700 | 3/709 | 1409 | | | 751090 | 58 | | | 8260 | | 7.0 | 6.0 | | 450 | 450 | 378 | | WB | | 3100 |
| 17 | 200 | 739 | 739 | | 1478 | | | 770410 | 61 | | | 5620 | 7.2 | 7.2 | 6.0 | 465 | 450 | 450 | 378 | | RP | | 2900 |
| 18 | 200 | | 723 | 3/723 | 1446 | | | 991800 | 64 | | | 6820 | 7.2 | 7.2 | | 465 | 450 | | 378 | | FU | | 2400 |
| 19 | 200 | 720 | 720 | | 1440 | | | 932930 | 67 | | | 7070 | 7.2 | 7.2 | | 465 | 450 | | 378 | | DR | | 2300 |
| 20 | 200 | 720 | 720 | | 1440 | | | 857570 | 70 | | | 7160 | 7.2 | 7.2 | | 450 | 450 | | 378 | | RP | | 2400 |
| 21 | 200 | 720 | 720 | | 1440 | | | 875040 | 59 | | | 7740 | 7.1 | 7.1 | | 450 | 450 | | 377 | | WB | | 3300 |
| 22 | 200 | 720 | 720 | | 1440 | | | 765630 | 59 | | | 7410 | 7.1 | 7.1 | | 450 | 450 | | 377 | | RP | | 3600 |
| 23 | 200 | 720 | 720 | | 1440 | | | 895770 | 65 | | | 6120 | 7.1 | 7.1 | | 450 | 450 | | 377 | | RP | | 3000 |
| 24 | 200 | 720 | 720 | | 1440 | | | 936350 | 72 | | | 4970 | 7.1 | 7.1 | | 450 | 450 | | 375 | | RP | | 2900 |
| 25 | 200 | 720 | 720 | | 1440 | | | 1231880 | 75 | | | 5040 | 7.1 | 7.1 | | 450 | 450 | | 377 | | DT | | 2300 |
| 26 | 200 | 720 | 720 | | 1440 | | | 926200 | 72 | | | 5710 | 7.1 | 7.1 | | 450 | 450 | | 376 | | FU | | 2900 |
| 27 | 200 | 720 | 720 | | 1440 | | | 913450 | 78 | | | 6750 | 7.1 | 7.1 | | 450 | 450 | | 376 | | RP | | 2200 |
| 28 | 200 | 720 | 720 | | 1440 | | | 915390 | 64 | | | 4370 | 7.1 | 7.1 | | 450 | 450 | | 376 | | RP | | 2200 |
| 29 | 200 | 750 | 750 | | 1500 | | | 993420 | 55 | | | 3980 | 7.1 | 7.1 | | 450 | 450 | | 377 | | RP | | 2300 |
| 30 | 200 | 720 | 720 | | 1440 | | | 876580 | 56 | | | 6330 | 7.1 | 7.1 | | 450 | 450 | | 376 | | RP | | 2900 |
| 31 | 200 | 240 | 720 | 3/480 | 1440 | | | 900010 | 62 | | | 5110 | 7.1 | 7.1 | 7.1 | 450 | 450 | 450 | 377 | | RP | | 1500 |
| TOTAL | 6200 | 9769 | 12320 | 271/24477 | 49337 | 2750 | 7062 | 15593290 | 2142 | | | 205290 | 113.9 | 127.9 | 109.1 | 7260 | 8130 | 8325 | 11671 | 84 | | | 81500 |
| MAXIMUM | 200 | 750 | 750 | 73/1983 | 1983 | 209 | 918 | 1031880 | 83 | | | 14570 | 7.2 | 7.2 | 7.1 | 465 | 465 | 465 | 378 | 6 | | | 3600 |
| MINIMUM | 200 | 120 | 60 | 120/1419 | 1409 | 100 | 212 | 10130 | 58 | | | 3980 | 7.0 | 7.0 | 6.0 | 450 | 450 | 450 | 375 | 6 | | | 1500 |
| AVERAGE | 200 | 651 | 684 | 692/1748 | 1592 | 196 | 504 | 503009 | 69 | | | 6622 | 7.1 | 7.1 | 6.1 | 453 | 451 | 462 | 376 | 6 | | | 2629 |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 990; OIL: 39; NAT GAS: 643

REMARKS: * Nº2 OIL 7062; RECLAIMED OIL F.S.: 0

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: Rodney G. Phillips | DATE: 12 NOV 95

APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 5-98, 1 JUN 58, WHICH WILL BE USED.

SEPT

A.5-65

# FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION HEADQUARTERS FORT STEWART
FORT STEWART, GEORGIA 31313

PLANT CENTRAL ENERGY PLANT | BLDG. NO. 1412

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 1 1,000 LB. (2) | BOILER 2/3 1,000 LB. (3) | BOILER 4 1,000 LB. (4) | TOTAL 1,000 LB. (5) | WOOD TONS (6) | No 2 OIL FUEL USED GAL. * (7) | NAT GAS (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. (10) | FEEDWATER HEATER TEMP. °F. (11) | MAKEUP GAL. (12) | %CO2 BOILER 1 (13) | %CO2 BOILER 2/3 (14) | %CO2 BOILER 4 (15) | FLUE GAS TEMPERATURE BOILER 1 °F. (16) | FLUE GAS BOILER 2/3 °F. (17) | FLUE GAS BOILER 4 °F. (18) | TEMP. H.W. SUPPLY °F. (19) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 200 | | 385 | 1626 | 2011 | 204 | 1100 | 24070 | 78 | | | | | | | | | | |
| 2 | 200 | | 360 | 1838 | 2198 | 250 | 145 | 25400 | 78 | | | 6230 | | 7.2 | 6.0 | | 420 | 465 | 375 |
| 3 | 200 | | 60 | 2010 | 2070 | 271 | 320 | 65130 | 74 | | | 7940 | | 7.2 | 6.0 | | 420 | 465 | 375 |
| 4 | 200 | | 264 | 1889 | 2153 | 245 | 590 | 181000 | 76 | | | 8070 | | 7.2 | 6.0 | | 420 | 465 | 375 |
| 5 | 200 | | | 2060 | 2060 | 279 | 250 | 44180 | 68 | | | 7700 | | 7.2 | 6.0 | | 420 | 465 | 375 |
| 6 | 200 | | | 1802 | 1802 | 202 | 1818 | 25200 | 70 | | | 7500 | | | 6.0 | | | 465 | 375 |
| 7 | 200 | | | 1716 | 1716 | 236 | 871 | 25740 | 71 | | | 8860 | | | 6.0 | | | 465 | 375 |
| 8 | 200 | | | 1666 | 1666 | 223 | 350 | 40270 | 75 | | | 5560 | | | 6.0 | | | 465 | 375 |
| 9 | 200 | | | 1718 | 1718 | 235 | 120 | 29640 | 77 | | | 10300 | | | 6.0 | | | 465 | 375 |
| 10 | 200 | | | 1694 | 1694 | 230 | 160 | 24600 | 78 | | | 7020 | | | 6.0 | | | 465 | 375 |
| 11 | 200 | | | 1702 | 1702 | 230 | 190 | 28060 | 76 | | | 8560 | | | 6.0 | | | 465 | 375 |
| 12 | 200 | | | 1677 | 1677 | 226 | 265 | 26100 | 74 | | | 6130 | | | 6.0 | | | 466 | 376 |
| 13 | 200 | | | 1689 | 1689 | 229 | 201 | 24940 | 76 | | | 6120 | | | 6.0 | | | 466 | 376 |
| 14 | 200 | | | 1717 | 1717 | 236 | 443 | 101820 | 77 | | | 6990 | | | 6.0 | | | 466 | 376 |
| 15 | 200 | | | 1667 | 1667 | 225 | 269 | 25100 | 78 | | | 11980 | | | 6.0 | | | 466 | 376 |
| 16 | 200 | | | 1666 | 1666 | 225 | 200 | 20508 | 80 | | | 6280 | | | 6.0 | | | 466 | 376 |
| 17 | 200 | | 73 | 1495 | 1568 | 200 | 345 | 24200 | 80 | | | 6570 | | | 6.0 | | | 466 | 376 |
| 18 | 200 | | | 1642 | 1642 | 222 | 253 | 46700 | 77 | | | 7990 | | 7.2 | 6.0 | | 420 | 465 | 375 |
| 19 | 200 | | | 1601 | 1601 | 207 | 97 | 14400 | 75 | | | 8650 | | | 6.0 | | | 465 | 375 |
| 20 | 200 | | | 1585 | 1585 | 215 | 142 | 19340 | 73 | | | 8510 | | | 6.0 | | | 465 | 375 |
| 21 | 200 | | | 1578 | 1578 | 218 | 289 | 109180 | 75 | | | 9720 | | | 6.0 | | | 465 | 375 |
| 22 | 200 | | | 1538 | 1538 | 205 | 360 | 106570 | 81 | | | 7250 | | | 6.0 | | | 465 | 375 |
| 23 | 200 | | | 1574 | 1574 | 210 | 350 | 23530 | 71 | | | 6760 | | | 6.0 | | | 466 | 376 |
| 24 | 200 | | | 1524 | 1524 | 206 | 212 | 24100 | 55 | | | 4550 | | | 6.0 | | | 466 | 376 |
| 25 | 200 | | 1080 | 404 | 1484 | 44 | 215 | 767800 | 68 | | | 6280 | | | 6.0 | | | 466 | 376 |
| 26 | 200 | | 100 | 1499 | 1599 | 160 | 169 | 58530 | 70 | | | 6330 | | 7.2 | 6.0 | | 420 | 466 | 376 |
| 27 | 200 | | | 1507 | 1507 | 148 | 2562 | 11920 | 70 | | | 3780 | | 7.2 | 6.0 | | 420 | 466 | 376 |
| 28 | 200 | | | 1502 | 1502 | 206 | 3544 | 10802 | 70 | | | 4080 | | | 6.0 | | | 466 | 376 |
| 29 | 200 | | | 1529 | 1529 | 174 | 3397 | 15090 | 67 | | | 7400 | | | 6.0 | | | 466 | 376 |
| 30 | 200 | | | 1475 | 1475 | 202 | 2503 | 16620 | 68 | | | 5020 | | | 6.0 | | | 466 | 376 |
| 31 | | | | | | | | | | | | 6320 | | | 6.0 | | | 466 | 376 |
| TAL | 6,000 | | 2322 | 48590 | 50912 | 6363 | 21730 | [illegible] | 2276 | | | | | | | | | | |
| IMUM | 200 | | 1080 | 2060 | 2198 | 279 | 3544 | 767800 | 81 | | | 216450 | | 50.4 | 180.0 | | 2940 | 13966 | 11265 |
| IMUM | 200 | | 60 | 404 | 1475 | 44 | 97 | 10802 | 55 | | | 11980 | | 7.2 | 6.0 | | 420 | 466 | 376 |
| RAGE | 200 | | 332 | 1620 | 1697 | 213 | 725 | 73343 | 76 | | | 3780 | | 7.2 | 6.0 | | 420 | 465 | 375 |
| FORATION LB. STEAM PER LB. STD. FUEL | | | | | | | | | | | | 7215 | | 7.2 | 6.0 | | 420 | 466 | 376 |

FUEL USED DURING MONTH (STANDARD TONS)

WOOD: 2291 ; OIL: 121; NAT GAS: 91

REMARKS

* N°2 OIL 9824 ; RECLAIMED OIL F.S.: 1

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY Rodney G. Phillips | DATE 15 Oct 95

APPROVED BY | DATE | POST ENG

FORM 3967
1 NOV 7?

MONTH

SEPTEMBER 1995

| TUBES CLEANED NUMBER OF TIMES | PREVENT MAINT. CHECK | | CHILL WATER M/U |
|---|---|---|---|
| (20) | (21) | (22) | (23) |
| 6 | FU | | 2700 |
| 6 | DR | | 3000 |
| 6 | FU | | 2800 |
| 6 | DR | | 2600 |
| 6 | FU | | 4100 |
| 6 | DR | | 3300 |
| 6 | FU | | 2200 |
| 6 | DR | | 3200 |
| 6 | FU | | 2400 |
| 6 | DR | | 2600 |
| 6 | FU | | 2900 |
| 6 | DR | | 2700 |
| 6 | FU | | 2900 |
| 6 | DR | | 3600 |
| 6 | FU | | 2600 |
| 6 | DR | | 2600 |
| 6 | FU | | 3000 |
| 6 | DR | | 3100 |
| 6 | FU | | 3000 |
| 6 | EB | | 3600 |
| 6 | DR | | 2700 |
| 6 | FU | | 2600 |
| 6 | FU | | 3100 |
| 6 | FU | | 3800 |
| 6 | FU | | 3600 |
| 6 | DR | | 2200 |
| 6 | DR | | 2900 |
| 6 | DR | | 3000 |
| 6 | RS | | 2700 |
| 6 | RS | | 2500 |
| | | | |
| 180 | | | 87,900 |
| 6 | | | 4100 |
| 6 | | | 2200 |
| 6 | | | 2930 |

L 906

NEER | DATE

A.5-66

A.5-67

**FACILITIES ENGINEERING OPERATING LOG** *(Boiler Plant)*

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CENTRAL ENERGY PLANT | BLDG. NO. 1412 | MONTH: AUGUST 1995

| DATE | STEAM PRODUCED: STEAM PRESSURE LB. (1) | BOILER 1 1,000 LB. (2) | BOILER 2-3 1,000 LB. (3) | BOILER 4 1,000 LB. (4) | TOTAL 1,000 LB. (5) | WOOD TONS (6) | NO. 2 OIL FUEL USED GAL. * (7) | NAT GAS (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. (10) | FEEDWATER HEATER TEMP. °F. (11) | MAKEUP GAL. (12) | %CO2 BOILER 1 (13) | %CO2 BOILER 2-3 (14) | %CO2 BOILER 4 (15) | FLUE GAS TEMP. BOILER 1 °F. (16) | FLUE GAS TEMP. BOILER 2-3 °F. (17) | FLUE GAS TEMP. BOILER 4 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | (22) | CHILL WATER m/u (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 200 | | | 1958 | 1958 | 201 | 169 | 5000 | 79 | | | 8710 | | | 7.0 | | | 465 | 375 | 6 | DR | | 3700 |
| 2 | 200 | | | 1963 | 1963 | 267 | 201 | 36410 | 80 | | | 9470 | | | 7.0 | | | 465 | 375 | 6 | CP | | 4280 |
| 3 | 200 | 120 | 120- | 1813 | 2053 | 236 | 766 | 109740 | 73 | | | 9580 | 7.8 | 7.8- | 7.0 | 420 | 420 - | 465 | 375 | 6 | EF | | 3800 |
| 4 | 200 | | | 1969 | 1969 | 269 | 124 | 12010 | 75 | | | 7020 | | | 7.0 | | | 465 | 375 | 6 | DR | | 4000 |
| 5 | 200 | | | 1906 | 1906 | 261 | 61 | 14100 | 80 | | | 10200 | | | 7.0 | | | 465 | 375 | 6 | FU | | 3900 |
| 6 | 200 | | | 1859 | 1859 | 254 | 376 | 22580 | 80 | | | 8420 | | | 7.0 | | | 465 | 375 | 6 | DR | | 3800 |
| 7 | 200 | | | 1884 | 1884 | 247 | 736 | 14300 | 80 | | | 10430 | | | 7.0 | | | 465 | 375 | 6 | FU | | 4100 |
| 8 | 200 | | | 1920 | 1920 | 259 | 300 | 16340 | 80 | | | 7210 | | | 7.0 | | | 465 | 375 | 6 | DR | | 3600 |
| 9 | 200 | | | 1891 | 1891 | 228 | 142 | 22080 | 72 | | | 5910 | | | 7.0 | | | 465 | 375 | 6 | CP | | 2200 |
| 10 | 200 | | | 1861 | 1861 | 254 | 297 | 103010 | 74 | | | 7260 | | | 7.0 | | | 465 | 375 | 6 | EF | | 2600 |
| 11 | 200 | | | 1862 | 1862 | 244 | 700 | 24100 | 82 | | | 6470 | | | 7.0 | | | 465 | 375 | 6 | FU | | 2700 |
| 12 | 200 | 440 | 440-400 | 519 | 1799 | 71 | 536 | 752600 | 87 | | | 8320 | 7.8 | 7.8-7.8 | 7.0 | 420 | 420-420 | 465 | 375 | 6 | DR | | 4200 |
| 13 | 200 | 180 | 176-103 | 1439 | 1898 | 188 | 515 | 289360 | 85 | | | 6970 | 7.8 | 7.8-7.8 | 7.0 | 420 | 420-420 | 465 | 375 | 6 | FU | | 2600 |
| 14 | 200 | | | 1841 | 1841 | 248 | 280 | 1110 | 85 | | | 6640 | | | 7.0 | | | 465 | 375 | 6 | DR | | 2600 |
| 15 | 200 | | | 1780 | 1780 | 240 | 254 | 4000 | 81 | | | 8410 | | | 6.0 | | | 465 | 375 | 6 | FU | | 3400 |
| 16 | 200 | | | 1847 | 1847 | 252 | 100 | 18020 | 83 | | | 7340 | | | 6.0 | | | 465 | 375 | 6 | CP | | 2840 |
| 17 | 200 | | | 1832 | 1832 | 247 | 348 | 9640 | 90 | | | 6900 | | | 6.0 | | | 465 | 375 | 6 | EF | | 3260 |
| 18 | 200 | | | 1826 | 1826 | 234 | 910 | 9280 | 91 | | | 7630 | | | 6.0 | | | 465 | 375 | 6 | DR | | 3800 |
| 19 | 200 | | | 1808 | 1808 | 242 | 487 | 13300 | 80 | | | 6560 | | | 6.0 | | | 465 | 375 | 6 | FU | | 3400 |
| 20 | 200 | | | 1820 | 1820 | 239 | 600 | 11440 | 77 | | | 5820 | | | 6.0 | | | 465 | 375 | 6 | DR | | 2900 |
| 21 | 200 | | | 1809 | 1809 | 247 | 147 | 6900 | 78 | | | 8020 | | | 6.0 | | | 465 | 375 | 6 | FU | | 3000 |
| 22 | 200 | | | 1770 | 1770 | 240 | 190 | 2200 | 78 | | | 5420 | | | 6.0 | | | 465 | 375 | 6 | DR | | 3100 |
| 23 | 200 | | | 1814 | 1814 | 201 | 1122 | 9260 | 75 | | | 5720 | | | 6.0 | | | 465 | 375 | 6 | CP | | 2900 |
| 24 | 200 | | | 1855 | 1855 | 136 | 2054 | 30580 | 73 | | | 6840 | | | 6.0 | | | 465 | 375 | 6 | EF | | 2300 |
| 25 | 200 | | 160 | 1837 | 1997 | 128 | 2500 | 169400 | 74 | | | 10490 | | 7.8 | 6.0 | | 420 | 465 | 375 | 6 | FU | | 3800 |
| 26 | 200 | | 225 | 1778 | 2003 | 199 | 1890 | 237510 | 75 | | | 7220 | | 7.8 | 6.0 | | 420 | 465 | 375 | 6 | DR | | 1600 |
| 27 | 200 | | 600 | 1756 | 2356 | 240 | 121 | 517000 | 84 | | | 8840 | | 7.8 | 6.0 | | 420 | 465 | 375 | 6 | FU | | 3000 |
| 28 | 200 | | 475 | 1616 | 2091 | 219 | 160 | 523420 | 78 | | | 8430 | | 7.8 | 6.0 | | 420 | 465 | 375 | 6 | DR | | 2800 |
| 29 | 200 | | 575 | 1738 | 2303 | 233 | 370 | 450,000 | 78 | | | 7290 | | 7.8 | 6.0 | | 420 | 465 | 375 | 6 | FU | | 2800 |
| 30 | 200 | | 500 | 1657 | 2157 | 202 | 1445 | 379580 | 77 | | | 6740 | | 7.8 | 6.0 | | 420 | 465 | 375 | 6 | EF | | 2200 |
| 31 | 200 | 60 | 408-58 | 1508 | 2034 | 165 | 2334 | 518030 | 76 | | | 6930 | 7.8 | 7.8-7.8 | 6.0 | 420 | 420-420 | 465 | 375 | 6 | CP | | 2500 |
| TOTAL | 6200 | 800 | 1141-3096 | 54736 | 59766 | 6891 | 20225 | 4,342,220 | 2382 | | | 237210 | 31.2 | 31.2-70.2 | 200 | 1690 | 1680-[illegible] | 14416 | 11625 | 186 | | | 101,380 |
| MAXIMUM | 200 | 440 | 440-600 | 1969 | 2356 | 269 | 2500 | 752600 | 91 | | | 10490 | 7.8 | 7.8-7.8 | 7.0 | 420 | 420,420 | 465 | 375 | 6 | | | 4280 |
| MINIMUM | 200 | 60 | 120-58 | 519 | 1770 | 71 | 61 | 2200 | 72 | | | 5320 | 7.8 | 7.8-7.8 | 6.0 | 420 | 420,420 | 465 | 375 | 6 | | | 1600 |
| AVERAGE | 200 | 200 | 286-344 | 1766 | 1928 | 222.3 | 652.4 | 140072 | 77 | | | 7652 | 7.8 | 7.8-7.8 | 6.4 | 420 | 420,420 | 465 | 375 | 6 | | | 3270 |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 2481; OIL: 112; NAT GAS: 179

REMARKS: * N°2 OIL: 13,671; RECLAIMED OIL FS.: 6554

PREPARED BY: Rodney D. Phillips | DATE: 10 Dep 95

APPROVED BY | DATE | POST ENGINEER | DATE

SEE REVERSE SIDE FOR INSTRUCTIONS

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 590, 1 JUN 58, WHICH WILL BE USED.

A.5-68

# FACIL[illegible]S ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTA[illegible] HEADQUARTERS FORT STEWART
FORT STEWART, GEORGIA 31313

PLANT: CENTRAL ENERGY PLANT | BLDG. NO: 1412 | MONTH: JULY 1995

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 1 1,000 LB. (2) | BOILER 2/3 1,000 LB. (3) | BOILER 4 1,000 LB. (4) | TOTAL 1,000 LB. (5) | ~~FEED WATER~~ WOOD TONS ~~BOILER~~ 1,000 LB. (6) | NO 2 OIL FUEL USED ~~LB.-M.C.F.~~ GAL. * (7) | NAT GAS ~~EVAP. LB. PER UNIT~~ (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. (10) | FEEDWATER HEATER TEMP. °F. (11) | MAKEUP GAL. (12) | %CO2 BOILER 1 (13) | %CO2 BOILER 2/3 (14) | %CO2 BOILER 4 (15) | FLUE GAS TEMPERATURE BOILER 1 °F. (16) | FLUE GAS BOILER 2/3 °F. (17) | FLUE GAS BOILER 4 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | (22) | CHILL WATER MAKE UP (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 200 | 453 | 400/97 | 512 | 1502 | 79 | 479 | 566010 | 75 | | | 4430 | 8.0 | 8.2/8.2 | 8.4 | 420 | 420/420 | 465 | 378 | 1 | WB | | 700 |
| 2 | 200 | | | 1295 | 1295 | 138 | 201 | 18570 | 73 | | | 10620 | | | 8.0 | | | 465 | 378 | 6 | EF | | 1600 |
| 3 | 200 | | | 1233 | 1233 | 170 | 424 | 18890 | 74 | | | 3470 | | | 8.5 | | | 465 | 375 | 6 | EF | | 400 |
| 4 | 200 | | | 1297 | 1297 | 179 | 83 | 12070 | 79 | | | 6990 | | | 8.0 | | | 465 | 378 | 6 | WB | | 1000 |
| 5 | 200 | | | 1294 | 1294 | 178 | 84 | 20730 | 81 | | | 6240 | | | 8.0 | | | 465 | 378 | 6 | RP | | 3100 |
| 6 | 200 | | | 1304 | 1304 | 180 | 424 | 16700 | 78 | | | 7810 | | | 7.6 | | | 465 | 376 | 6 | WB | | 3600 |
| 7 | 200 | | | 1257 | 1257 | 173 | 275 | 15200 | 76 | | | 7480 | | | 7.8 | | | 465 | 376 | 6 | DR | | 3600 |
| 8 | 200 | | | 1261 | 1261 | 172 | 88 | 20600 | 77 | | | 8010 | | | 7.8 | | | 465 | 376 | 6 | DR | | 3500 |
| 9 | 200 | | | 1242 | 1242 | 171 | 105 | 22480 | 77 | | | 9520 | | | 7.8 | | | 465 | 375 | 6 | DR | | 3800 |
| 10 | 200 | | | 1269 | 1269 | 171 | 163 | 7200 | 78 | | | 8050 | | | 7.6 | | | 468 | 377 | 6 | EB | | 4200 |
| 11 | 200 | 150 | 200/ | 1010 | 1360 | 139 | 238 | 217620 | 74 | | | 6780 | 8.0 | 8.2/ | 7.8 | 420 | 420/ | 466 | 378 | 6 | DR | | 4100 |
| 12 | 200 | 371 | 491/ | 546 | 1408 | 25 | 368 | 501700 | 77 | | | 9470 | 8.0 | 8.2/ | 7.8 | 420 | 420/ | 465 | 375 | 0 | RP | | 3100 |
| 13 | 200 | 826 | 36/557 | 0 | 1419 | 0 | 424 | 943660 | 69 | | | 4470 | 8.0 | 8.2/8.2 | 0 | 420 | 420/420 | 0 | 375 | 0 | RP | | 1200 |
| 14 | 200 | 524 | /500 | 293 | 1317 | 37 | 183 | 632020 | 73 | | | 5610 | 8.0 | /8.2 | 7.9 | 420 | /420 | 465 | 378 | 2 | EF | | 2000 |
| 15 | 200 | | | 1293 | 1293 | 178 | 424 | 3020 | 75 | | | 8480 | | | 8.1 | | | 465 | 378 | 6 | EF | | 2700 |
| 16 | 200 | | | 1272 | 1272 | 173 | 72 | 4990 | 79 | | | 8390 | | | 8.0 | | | 465 | 378 | 6 | EF | | 2500 |
| 17 | 200 | | | 1272 | 1272 | 140 | 262 | 6710 | 70 | | | 7710 | | | 8.0 | | | 465 | 378 | 6 | DR | | 2000 |
| 18 | 200 | | | 1292 | 1292 | 173 | 280 | 7680 | 74 | | | 7640 | | | 8.2 | | | 466 | 378 | 6 | EF | | 2000 |
| 19 | 200 | | | 1447 | 1447 | 199 | 241 | 7310 | 76 | | | 9320 | | | 8.0 | | | 465 | 377 | 6 | WB | | 2300 |
| 20 | 200 | | | 1442 | 1442 | 193 | 315 | 10470 | 81 | | | 9930 | | | 8.0 | | | 466 | 378 | 6 | RP | | 3300 |
| 21 | 200 | | | 1713 | 1713 | 236 | 180 | 17360 | 81 | | | 9370 | | | 8.0 | | | 465 | 378 | 6 | DR | | 3600 |
| 22 | 200 | | | 1804 | 1804 | 231 | 57 | 4690 | 82 | | | 9080 | | | 7.0 | | | 465 | 378 | 6 | FU | | 3700 |
| 23 | 200 | | | 1765 | 1765 | 241 | 132 | 2400 | 86 | | | 7480 | | | 8.0 | | | 465 | 378 | 6 | DR | | 3300 |
| 24 | 200 | | | 1820 | 1820 | 247 | 212 | 5500 | 82 | | | 8180 | | | 7.0 | | | 465 | 378 | 6 | FU | | 3300 |
| 25 | 200 | | | 1535 | 1535 | 200 | 670 | 29790 | 80 | | | 11360 | | | 8.0 | | | 465 | 378 | 6 | DR | | 3500 |
| 26 | 200 | | | 1867 | 1867 | 245 | 90 | 20800 | 80 | | | 11130 | | | 6.5 | | | 465 | 376 | 6 | WB | | 3500 |
| 27 | 200 | | /90 | 1754 | 1844 | 212 | 73 | 48970 | 76 | | | 20890 | | /8.2 | 7.0 | | /420 | 465 | 378 | 6 | EF | | 2800 |
| 28 | 200 | | /301 | 1500 | 1801 | 167 | 2337 | 21800 | 78 | | | 10420 | | /8.2 | 7.0 | | /420 | 465 | 378 | 6 | FU | | 3500 |
| 29 | 200 | | | 1796 | 1796 | 220 | 1608 | 25350 | 78 | | | 8090 | | | 7.0 | | | 465 | 376 | 6 | WB | | 3200 |
| 30 | 200 | | | 1833 | 1833 | 219 | 1920 | 30400 | 80 | | | 9080 | | | 7.0 | | | 465 | 377 | 6 | FU | | 3800 |
| 31 | 200 | | | 1901 | 1901 | 210 | 3054 | 10900 | 75 | | | 9820 | | | 7.0 | | | 465 | 376 | 6 | DR | | 3800 |
| TOTAL | 6200 | 2324 | 1167/1545 | 41119 | 46155 | 5316 | 15466 | 3381870 | 2394 | | | 265320 | 40.0 | 32.8/40.8 | 238.8 | 2100 | 1680/2100 | 13911 | 11691 | 165 | | | 88,700 |
| MAXIMUM | 200 | 826 | 491/557 | 1901 | 1901 | 247 | 3054 | 943660 | 86 | | | 20890 | 8.0 | 8.2/8.2 | 8.5 | 420 | 420/420 | 468 | 378 | 6 | | | 4200 |
| MINIMUM | 200 | 150 | 36/90 | 293 | 1242 | 25 | 57 | 2480 | 69 | | | 4430 | 8.0 | 8.2/8.2 | 6.5 | 420 | 420/420 | 0 | 375 | 0 | | | 400 |
| AVERAGE | 200 | 588 | 292/309 | 1371 | 1489 | 171 | 499 | 109093 | 77 | | | 8544 | 8.0 | 8.2/8.2 | 7.7 | 420 | 420/420 | 449 | 377 | 5.3 | | | 2861 |

EVAPORATION LB. STEAM PER LB. STD. FUEL: .36

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 1914; OIL: 86; N.G.: 139

REMARKS: * NO 2 OIL: 4,851; RECLAIMED OIL F.S.: 10,615.

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: Rodney G. Phillips [signature] | DATE: 8 AUG 95 | APPROVED BY: | DATE: | POST ENGINEER: | DATE:

DA FORM 3967, 1 NOV 72 REPLACES DA FORM 5-98, 1 JUN 58, WHICH WILL BE USED.

A.5-69

# FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CEP | BLDG. NO: 1412 | MONTH: June 1985

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 1 1,000 LB. (2) | BOILER 2 1,000 LB. (3) | BOILER 4 1,000 LB. (4) | TOTAL 1,000 LB. (5) | FEEDWATER TO BOILER 1,000 LB. (6) | #2 FUEL USED LB. M.C.F. GAL. (7) | N.G. EVAP. LB. PER UNIT (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. W/O (10) | FEEDWATER HEATER TEMP. °F. (11) | MAKEUP GAL. (12) | %CO2 BOILER 1 (13) | %CO2 BOILER 2 (14) | %CO2 BOILER 4 (15) 7.6 | FLUE GAS TEMP. BOILER 1 °F. (16) | BOILER 2 °F. (17) | BOILER 4 (18) ~~465~~ | TEMP H.W. SUPPLY (19) 375 | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | #4 O/S (22) | CWMA (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 200 | | | 1265 | 1265 | 173 | 74 | 16430 | 84 | 0 | | 7500 | | | 7.5 | | | 465 | 375 | 6 | DT | 10 | 1600 |
| 2 | 200 | | | 1274 | 1274 | 173 | 112 | 5360 | 84 | 0 | | 6180 | | | 7.5 | | | 465 | 375 | 6 | PM | 15 | 1605 |
| 3 | 200 | | | 1263 | 1263 | 138 | 3056 | 8590 | 78 | 1994 | | 5920 | | | 7.5 | | | 465 | 376 | 6 | CCP | 163 | 1045 |
| 4 | 200 | | | 1282 | 1282 | 113 | 3356 | 23,050 | 82 | 3482 | | 8410 | | | 7.5 | | | 465 | 376 | 6 | CCP | 459 | 1217 |
| 5 | 200 | 484 | | 1052 | 1536 | 96 | 2528 | 368,080 | 81 | -0- | | 7600 | 11 | | 7.5 | 420 | | 465 | 375 | 6 | EZ | 334 | 1000 |
| 6 | 200 | 240 | | 1221 | 1461 | 148 | 1130 | 174,340 | 86.6 | -0- | | 9190 | 11 | | 7.5 | 420 | | 465 | 376 | 6 | CCP | 149 | 1252 |
| 7 | 200 | | | 1398 | 1398 | 185 | 427 | 12,910 | 91 | 0 | | 8430 | | | 7.5 | ~~480~~ | | 465 | 376 | 6 | DT | 58 | 1050 |
| 8 | 200 | | | 1427 | 1427 | 194 | 144 | 0 | 91 | 0 | | 5840 | | | 7.5 | ~~480~~ | | 465 | 376 | 6 | DT | 58 | 1000 |
| 9 | 200 | | | 1351 | 1351 | 183 | 111 | 0 | 92 | 0 | | 5910 | | | 7.5 | | | 465 | 376 | 6 | EZ | 15 | 1100 |
| 10 | 200 | | | 1415 | 1415 | 194 | 975 | 17,100 | 86 | 0 | | 5520 | | | 7.5 | ~~480~~ | | 465 | 376 | 6 | CCP | 37 | 825 |
| 11 | 200 | | | 1370 | 1370 | 129 | 172 | 13,869 | 89 | 0 | | 8310 | | | 7.5 | ~~480~~ | | 465 | 376 | 6 | DT | 22 | 1155 |
| 12 | 200 | ~~844~~ | | 421 | 1265 | 41 | 926 | 443120 | 88 | 0 | | 9230 | 11 | | 7.5 | 420 | 420 | 465 | 375 | 6 | DR | 122 | 1300 |
| 13 | 200 | 348 | 348 | 635 | 1331 | 87 | 629 | 425300 | 79 | 0 | | 11450 | 11 | 11 | 7.5 | 420 | 420 | 465 | 375 | 6 | RP | 86 | 2000 |
| 14 | 200 | | | 1384 | 1384 | 188 | 156 | 2608 | 78 | 0 | | 6480 | | | 7.8 | | | 420 | 377 | 6 | W | 21 | 1300 |
| 15 | 200 | | | 1363 | 1363 | 186 | 100 | 10640 | 78 | 0 | | 5440 | | | 7.5 | | | 420 | 377 | 6 | RP | 13 | 1600 |
| 16 | 200 | | | 1380 | 1880 | 190 | 112 | 4420 | 78 | 0 | | 7380 | | | 7.7 | | | 422 | 378 | 6 | Schang | 14 | 1700 |
| 17 | 200 | | | 1294 | 1294 | 178 | 131 | 5440 | 79 | 0 | | 8080 | | | 7.6 | | | 465 | 376 | 6 | W | 17 | 1400 |
| 18 | 200 | | | 1299 | 1299 | 178 | 100 | 9140 | 77 | 0 | | 7860 | | | 7.5 | | | 465 | 377 | 6 | EZ | 14 | 1500 |
| 19 | 200 | | | 1311 | 1311 | 181 | 8 | 10,440 | 79 | 0 | | 5700 | | | 7.5 | | | 465 | 375 | 6 | EZ | 1 | 1000 |
| 20 | 200 | | | 1321 | 1321 | 182 | 35 | 14480 | 79 | 0 | | 5630 | | | 7.4 | | | 415 | 378 | 6 | MW | 5 | 1200 |
| 21 | 200 | | | 1328 | 1328 | 188 | 25 | 8370 | 79 | 0 | | 6830 | | | 7.5 | | | 465 | 380 | 6 | W | 3 | 1500 |
| 22 | 200 | | | 1298 | 1298 | 174 | 270 | 11,160 | 84 | 0 | | 9310 | | | 7.5 | | | 465 | 380 | 6 | CCP | 36 | 2400 |
| 23 | 200 | | | 1383 | 1383 | 190 | 141 | 14766 | 84 | 0 | | 9960 | | | 7.5 | | | 465 | 375 | 6 | EZ | 19 | 1700 |
| 24 | 200 | | | 1306 | 1306 | 177 | 170 | 17755 | 85 | 0 | | 7900 | | | 7.8 | | | 465 | 375 | 6 | DT | 21 | 1400 |
| 25 | 200 | | | 1352 | 1352 | 179 | 184 | 4750 | 86 | 0 | | 7090 | | | 7.8 | | | 465 | 375 | 6 | DR | 21 | 1600 |
| 26 | 200 | | | 1302 | 1302 | 178 | 40 | 5550 | 80 | 0 | | 6240 | | | 7.6 | | | 465 | 375 | 6 | EZ | 5 | 1100 |
| 27 | 200 | | | 1303 | 1303 | 161 | 132 | 4730 | 79 | 0 | | 8960 | | | 7.6 | | | 465 | 375 | 6 | DR | 17 | 1300 |
| 28 | 200 | | | 1397 | 1397 | 179 | 760 | 9530 | 72 | 0 | | 9520 | | | 7.6 | | | 465 | 375 | 6 | CCP | 100 | 1600 |
| 29 | 200 | | | 1391 | 1391 | 183 | 428 | 14400 | 75 | 0 | | 7460 | | | 8.0 | | | 466 | 378 | 6 | W | 56 | 1700 |
| 30 | 200 | 697 | 666 | 240 | 1603 | 19 | 100 | ~~[illegible]~~ | 75 | 0 | | 4920 | 7.8 | 7.8 | 7.6 | 420 | 420 | 465 | 377 | 6 | W | 13 | 1400 |
| 31 | | | | | | | 16942 | 501400 | | | | | 0 | | | | | | | | | | |
| TOTAL | 6000 | 2613 | 1014 | 37026 | 40653 | 4768 | ~~7306~~ | 2,011,340 | 2459 | 5476 | | 224294 | 39.0 | 15.6 | 228 | 2100 | 1260 | 13950 | 11250 | 180 | | 2004 | 41544 |
| MAXIMUM | 200 | 844 | 666 | 1427 | 1603 | 194 | 3756 | 501400 | 92 | 3482 | | 11450 | 7.8 | 7.8 | 8.0 | 420 | 420 | 465 | 380 | 6 | | 459 | 2400 |
| MINIMUM | 200 | 240 | 348 | 240 | 1263 | 19 | 8 | 1160 | 72 | 1994 | | 4920 | 7.8 | 7.8 | 7.4 | 420 | 420 | 420 | 375 | 6 | | 1 | 825 |
| AVERAGE | 200 | 523 | 507 | 1234 | 1355 | 159 | 565 | 69391 | 82 | 2438 | | 7475 | 7.8 | 7.8 | 7.6 | 420 | 420 | 460 | 375 | 6 | | 67 | 1385 |

EVAPORATION LB. STEAM PER LB. STD. FUEL: 40653

FUEL USED DURING MONTH (STANDARD TONS):

REMARKS:

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: | DATE: | APPROVED BY: | DATE: | POST ENGINEER: | DATE:

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 5-98, 1 JUN 58, WHICH WILL BE USED.

A.5-70

#1 70% #2 ...

# FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is the Corps of Engineers.

INSTALLATION: Ft. Stewart | PLANT: CEP | BLDG. NO.: 1412 | MONTH: MAY - 1995

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 1 1,000 LB. (2) | BOILER 2 1,000 LB. (3) | BOILER 4 1,000 LB. (4) | TOTAL 1,000 LB. (5) | Wood FEED WATER TO BOILER 1,000 LB. (6) | No. 2 FUEL USED GAL. OIL (7) | N.G. EVAP. LB. PER UNIT (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER WO (10) | TEMP. °F. (11) | MAKEUP GAL. (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| #4 1 | 200 | | | 1231 | 1231 | 168 | 103 | 21920 | 86° | -0- | | 5980 |
| 2 | 200 | | | 1177 | 1177 | 157 | 295 | 22817 | 76.5 | 0 | | 6010 |
| 3 | 200 | | | 1244 | 1244 | 172 | 159 | 4040 | 71 | 0 | | 8030 |
| 4 | 200 | | | 1318 | 1318 | 182 | 112 | 3230 | 71 | 0 | | 5320 |
| 5 | 200 | | | 1231 | 1231 | 168 | 1099 | 5060 | 83 | 0 | | 4060 |
| 6 | 200 | | | 1226 | 1226 | 167 | 117 | 20940 | 75° | 0 | | 4220 |
| 7 | 200 | | | 1214 | 1214 | 165 | 138 | 9830 | 78 | 0 | | 3010 |
| 8 | 200 | 74.4 | 111.6 | 1043 | 1229 | 187 | 397 | 95900 | 82 | 0 | | 6450 |
| 9 | 200 | — | — | 1229 | 1229 | 166 | 219 | 3190 | 82 | 0 | | 3750 |
| 10 | 200 | | | 1188 | 1188 | 165 | 199 | 12050 | 84 | 0 | | 8950 |
| 11 | 200 | | | 1222 | 1222 | 164 | 1026 | 6480 | 77 | 0 | | 8110 |
| 12 | 200 | | | 1193 | 1193 | 160 | 1000 | 10210 | 85 | 3223 | | 8800 |
| 13 | 200 | | | 1192 | 1192 | 186 | 1000 | 5510 | 85 | 2238 | | 6440 |
| 14 | 200 | | | 1189 | 1189 | 184 | 1000 | 7720 | 89. | 3516 | | 10,390 |
| 15 | 200 | | | 1027 | 1027 | 175 | 1083 | 72710 | 87 | 2347 | | 2290 |
| 16 | 200 | | | 1228 | 1228 | 169 | 1008. | 6290 | 88.8 | -0- | | 11,300 |
| 17 | 200 | | | 1187 | 1187 | 163 | 1100 | 9800 | 87 | 0 | | 7640 |
| 18 | 200 | | | 1193 | 1193 | 162 | 1120 | 22260 | 89 | -0- | | 5,090 |
| 19 | 200 | | | 1170 | 1170 | 180 | 1078 | 6370 | 85 | -0- | | 7,570 |
| 20 | 200 | | | 1210 | 1210 | 166 | 1053 | 103770 | 76 | 0 | | 7,450 |
| 21 | 200 | | | 1182 | 1182 | 163 | 1266 | 3500 | 74 | -0- | | 7700 |
| 22 | 200 | | | 1230 | 1230 | 167 | 144 | 5120 | 76 | -0- | | 6610 |
| 23 | 200 | | | 1265 | 1265 | 170 | 257 | 7783 | 74.8 | -0- | | 5550 |
| 24 | 200 | | | 1273 | 1273 | 175 | 194 | 1,830 | 73 | 0 | | 7630 |
| 25 | 200 | | | 1251 | 1251 | 172 | 395 | 10640 | 81 | -0- | | 8710 |
| 26 | 200 | | | 1222 | 1222 | 188 | 1000 | 19,000 | 81 | -0- | | 4480 |
| 27 | 200 | | | 1225 | 1228 | 165 | 164 | 12,600 | 87 | -0- | | 6478 |
| 28 | 200 | | | 1196 | 1196 | 182 | 168 | 12785 | 81 | -0- | | 8600 |
| 29 | 200 | | | 1263 | 1263 | 189 | 261 | 19355 | 87 | -0- | | 6160 |
| 30 | 200 | | | 1295 | 1295 | 180 | 452 | 9660 | 88.9 | -0- | | 7890 |
| 31 | 200 | | | 1274 | 1274 | 185 | 292 | 7610 | 83. | 0 | | 5790 |
| TOTAL | 6200 | 744 | 111.6 | 37588 | 37774 | 5322 | 17849 | 550130 | 2520 | 11,324 | | 206680 |
| MAXIMUM | 200 | 744 | 111.6 | 1318 | 1318 | 189 | 1266 | 103770 | 89 | 3516 | | 11300 |
| MINIMUM | 200 | 74.4 | 111.6 | 1027 | 1027 | 154 | 103 | 1830 | 71 | 2238 | | 2290 |
| AVERAGE | 200 | 74.4 | 111.6 | 1213 | 1219 | 172 | 576 | 17746 | 81 | 2831 | | 6661 |

| DATE | % $CO_2$ BOILER 1 (13) | BOILER 2 (14) | BOILER 4 (15) | FLUE GAS TEMPERATURE BOILER 1 °F. (16) | BOILER 2 °F. (17) | BOILER 4 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | No. 4 OIS (22) | CWMU (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | 7.5 | | | 465 | 375 | 6 | CCP | 74 | 6100 |
| 2 | | | 7.5 | | | 465 | 375 | 6 | CCP | 39 | 9000 |
| 3 | | | 7.5 | | | 465 | 375 | 6 | DT | 21 | 10,200 |
| 4 | | | 7.5 | | | 465 | 375 | 6 | MW | 15 | 9200 |
| 5 | | | 7.5 | | | 465 | 375 | 6 | ET | 13 | 5100 |
| 6 | | | 7.5 | | | 465 | 375 | 6 | CCP | 16 | 1100 |
| 7 | | | 7.5 | | | 465 | 375 | 6 | ET | 19 | 700 |
| 8 | | | 7.5 | | | 465 | 375 | 6 | CCP | 53 | 800 |
| 9 | | | 7.5 | | | 465 | 375 | 6 | ET | 29 | 500 |
| 10 | | | 7.5 | | | 465 | 375 | 6 | DT | 27 | 1100 |
| 11 | | | 7.5 | | | 460 | 375 | 6 | D | 4 | 900 |
| 12 | | | 7.5 | | | 465 | 375 | 6 | RP | 396 | 900 |
| 13 | | | 7.5 | | | 465 | 375 | 6 | ET | 275 | 900 |
| 14 | | | 7.5 | | | 465 | 375 | 6 | CCP | 432 | 1140 |
| 15 | | | 7.5 | | | 465 | 375 | 6 | MW | 219 | 550 |
| 16 | | | 7.5 | | | 465 | 375 | 6 | CCP | 1. | 2340 |
| 17 | | | 7.5 | | | 465 | 375 | 6 | DT | 13 | 1150 |
| 18 | | | 7.5 | | | 465 | 378 | 6 | MW | 15 | 800 |
| 19 | | | 7.5 | | | 465 | 378 | 6 | [illegible] | 10 | 1000 |
| 20 | | | 7.5 | | | 465 | 377 | 6 | DT | 7 | 1100 |
| 21 | | | 7.5 | | | 465 | 376 | 6 | CCP | 0 | 2460 |
| 22 | | | 7.5 | | | 465 | 375 | 6 | ET | 7 | 1730 |
| 23 | | | 7.5 | | | 465 | 376 | 6 | CCP | 34 | 1750 |
| 24 | | | 7.5 | | | 465 | 376 | 6 | DT | 26 | 940 |
| 25 | | | 7.5 | | | 465 | 378 | 6 | MW | 45 | 2200 |
| 26 | | | 7.5 | | | 465 | 376 | 6 | CCP | -0- | 1810 |
| 27 | | | 7.5 | | | 465 | 375 | 6 | ET | 21 | 800 |
| 28 | | | 7.5 | | | 465 | 376 | 6 | CCP | 22 | 1160 |
| 29 | | | 7.5 | | | 465 | 376 | 6 | ET | 34 | 540 |
| 30 | | | 7.5 | | | 405 | 375 | 6 | CCP | 60 | 1100 |
| 31 | | | 7.5 | | | 405 | 375 | 6 | DT | 39 | 500 |
| TOTAL | | | 2326 | | | 14415 | 11625 | 186 | | 1906 | 69,520 |
| MAXIMUM | | | 7.5 | | | 465 | 375 | 6 | | 432 | 10,200 |
| MINIMUM | | | 7.5 | | | 465 | 375 | 6 | | 1 | 500 |
| AVERAGE | | | 7.5 | | | 465 | 375 | 6 | | 61 | 2244 |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 1 NOV 72 3967 REPLACES DA FORM 5-98, 1 JUN 58, WHICH WILL BE USED.

A.5-70

A.5-71

#1 40% #2 60% of load

**FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)**
For use of this form, see AR 420-49; the proponent agency is the Corps of Engineers.

INSTALLATION: FT. STEWART — PLANT: CEP — BLDG. NO.: 1412 — MONTH: APR-95

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 1 1,000 LB. (2) | BOILER 2 1,000 LB. (3) | BOILER 4 1,000 LB. (4) | TOTAL 1,000 LB. (5) | WOOD TONS 1,000 LB. (6) | NO 2 FUEL USED GAL. OIL (7) | N.G. (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER W/O (10) | TEMP. °F. (11) | MAKEUP GAL. (12) | % CO2 BOILER 1 (13) | % CO2 BOILER 2 (14) | % CO2 BOILER 4 (15) | FLUE GAS TEMPERATURE BOILER 1 °F. (16) | BOILER 2 °F. (17) | BOILER 4 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | #4 O/S (22) | CWMU (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| #H 1 | 200 | 179 | 249 | #4 904 | 1332 | 117 | 20 | 303,600 | 59 | — | | 14330 | 7.4 | 7.4 | 7.4 | 420 | 420 | 420 | 380 | 2 | [illegible] | 55 | 300 |
| 2 | 200 | 516 | 770 | | 1286 | -0- | -0- | 821,230 | 57 | -0- | | 9,910 | 7.4 | 7.4 | | 420 | 420 | | 380 | 0 | [illegible] | -0- | 500 |
| 3 | 200 | 611 | 816 | | 1427 | -0- | -0- | 866,400 | 60 | -0- | | 11,410 | 7.4 | 7.4 | | 420 | 420 | | 380 | 0 | [illegible] | -0- | 400 |
| 4 | 200 | 645 | 675 | | 1320 | -0- | -0- | 853920 | 66 | -0- | | 11,550 | 7.4 | 7.4 | | 420 | 420 | | 380 | 0 | [illegible] | -0- | 400 |
| 5 | 200 | 666 | 664 | | 1332 | 0 | 0 | 957980 | 58 | 0 | | 958[illegible] | 7.4 | 7.4 | | 420 | 420 | | 380 | 0 | [illegible] | 0 | 500 |
| 6 | 200 | 693 | 695 | | 1388 | 0 | 0 | 898878 | 56 | 0 | | 12550 | 7.4 | 7.4 | | 420 | 420 | | 380 | 0 | [illegible] | 0 | 800 |
| 7 | 200 | 579 | 645 | | 1228 | -0- | -0- | 864,700 | 62 | 0 | | 9140 | 7.4 | 7.4 | | 420 | 420 | | 380 | 0 | [illegible] | 0 | 800 |
| 8 | 200 | 591 | 633 | | 1224 | 0 | 0 | 898872 | 64 | 0 | | 10320 | 7.4 | 7.4 | | 420 | 420 | | 380 | 0 | [illegible] | 0 | 900 |
| 9 | 200 | 599 | 606 | | 1206 | 0 | 0 | 898872 | 67 | 0 | | 10890 | 7.4 | 7.4 | | 420 | 420 | | 380 | 0 | [illegible] | 0 | 500 |
| 10 | 200 | 566 | 581 | | 1147 | 0 | 0 | 898878 | 68 | 0 | | 10460 | 7.4 | 7.4 | | 420 | 420 | | 380 | 0 | [illegible] | 0 | 800 |
| 11 | 200 | 549 | 604 | | 1153 | 0 | 0 | 710,020 | 71 | 0 | | 7,720 | 7.4 | 7.4 | | 420 | 420 | | 380 | 0 | [illegible] | 0 | 800 |
| 12 | 200 | 549 | 576 | | 1125 | 0 | 0 | 696300 | 74 | 0 | | 7553 | 7.4 | 7.4 | | 420 | 420 | | 380 | 0 | [illegible] | 0 | 400 |
| 13 | 200 | 603 | 620 | | 1223 | 0 | 0 | 715000 | 75 | 0 | | 11,020 | 7.4 | 7.4 | 7.4 | 420 | 420 | 420 | 380 | 0 | [illegible] | 0 | 400 |
| 14 | 200 | 570 | 587 | #4 62 | 1219 | 0 | 26 | 696120 | 70 | 0 | | 10,580 | 7.4 | 7.4 | | 420 | 420 | | 380 | 0 | [illegible] | 62 | 500 |
| 15 | 200 | 585 | 600 | | 1185 | 0 | 0 | 717,150 | 74 | 0 | | 6900 | 7.4 | 7.4 | | 420 | 420 | | 380 | 0 | [illegible] | 0 | 300 |
| 16 | 200 | 558 | 614 | | 1172 | 0 | 0 | 665300 | 79 | 0 | | 8440 | 7.4 | 7.4 | | 420 | 420 | | 380 | 0 | [illegible] | 0 | 200 |
| 17 | 200 | 369 | 376 | #4 391 | 1136 | 44 | 52 | 458,440 | 81 | 0 | | 7340 | 7.4 | 7.4 | 7.4 | 420 | 420 | 420 | 380 | 6 | [illegible] | 44 | 450 |
| 18 | 200 | | | 1025 | 1025 | 135 | 43 | 6,650 | 81 | 0 | | 8490 | | | 7.4 | | | 465 | 388 | 6 | W | 8 | 350 |
| 19 | 200 | | | 904 | 904 | 115 | 46 | 10230 | 80 | 0 | | 8670 | | | 7.4 | | | 465 | 388 | 6 | [illegible] | 6 | 800 |
| 20 | 200 | | | 930 | 930 | 127 | 35 | 1840 | 80 | 0 | | 9791 0 | | | 7.4 | | | 465 | 380 | 6 | DT | 9 | 200 |
| 21 | 200 | | | 895 | 895 | 100 | 35 | 0 | 83 | 0 | | 7960 | | | 7.4 | | | 465 | 380 | 6 | [illegible] | 5 | 300 |
| 22 | 200 | | | 870 | 870 | 93 | 35 | 1,120 | 84 | 0 | | 10938 40 | | | 7.4 | | | 465 | 380 | 6 | DT | 9 | 500 |
| 23 | 200 | | | 890 | 890 | 106 | 25 | 240 | 84 | 0 | | 8580 | | | 7.4 | | | 465 | 380 | 6 | MW | 13 | 100 |
| 24 | 200 | | | 870 | 870 | 93 | 25 | 6490 | 78 | 0 | | 10600 | | | 7.4 | | | 465 | 378 | 6 | W | 34 | 400 |
| 25 | 200 | | | 1163 | 1163 | 151 | 65 | 2900 | 65 | 0 | | 7940 | | | 7.4 | | | 465 | 378 | 6 | [illegible] | 63 | 48,000 |
| 26 | 200 | | | 1246 | 1246 | 165 | 28 | 7850 | 70 | 0 | | 5746 | | | 7.4 | | | 465 | 375 | 6 | DT | 47 | 6560 |
| 27 | 200 | | | 1216 | 1216 | 168 | 27 | 5080 | 76 | 0 | | 6800 | | | 7.4 | | | 465 | 375 | 6 | [illegible] | 16 | 5800 |
| 28 | 200 | | | 1143 | 1143 | 155 | 24 | 15400 | 62 | 0 | | 1654 0 | | | 7.4 | | | 465 | 375 | 6 | DT | 14 | 5400 |
| 29 | 200 | | | 1223 | 1223 | 156 | 35 | 11,260 | 77 | 0 | | 7840 | - | - | 7.4 | | | 465 | 375 | 6 | CCP | 90 | 7000 |
| 30 | 200 | | | 1213 | 1213 | 166 | 24 | 4420 | 85 | 0 | | 5480 | | | 7.4 | | | 465 | 375 | 6 | [illegible] | 7 | 5800 |
| 31 | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | 6000 | 9828 | 10316 | 14946 | 34688 | 1869 | 550 | 12,996,580 | 2138 | 0 | | 264078 | 125.8 | 125.8 | 118.4 | 7140 | 7140 | 7305 | 11400 | 86 | | 76 | 90800 |
| MAXIMUM | 200 | 693 | 695 | 1246 | 1427 | 168 | 65 | 957980 | 85 | 0 | | 12390 | 7.4 | 7.4 | 7.4 | 420 | 420 | 465 | 380 | 6 | | 63 | 48000 |
| MINIMUM | 200 | 179 | 249 | 62 | 870 | 44 | 20 | 240 | 56 | 0 | | 5480 | 7.4 | 7.4 | 7.4 | 420 | 420 | 420 | 380 | 2 | | 3 | 100 |
| AVERAGE | 200 | 555 | 607 | 934 | 1156 | 125 | 34 | 433173 | 71 | 0 | | 8803 | 7.4 | 7.4 | 7.4 | 420 | 420 | 457 | 380 | 6 | | 6 | 3027 |

EVAPORATION LB. STEAM PER LB. STD. FUEL: [illegible]

FUEL USED DURING MONTH (STANDARD TONS): 41626 20551 78 13268

REMARKS: 274470

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY — DATE — APPROVED BY — DATE — POST ENGINEER — DATE

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 5-86, 1 JUN 56 WHICH WILL BE USED.

A.5-71

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is the Corps of Engineers.

INSTALLATION: Ft. Stew | PLANT: CEP | BLDG. NO.: 1412 | MONTH: MAR 95

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 4 1,000 LB. (2) | BOILER 1/2 1,000 LB. (3) | BOILER 3 1,000 LB. (4) | TOTAL 1,000 LB. (5) | WOOD TONS 1,000 LB. (6) | #2 FUEL USED GAL. (7) | N.G. (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER w/o (10) | FEEDWATER HEATER TEMP. °F. (11) | MAKEUP GAL. (12) | $CO_2$ BOILER 4 (13) | $CO_2$ BOILER (14) | $CO_2$ BOILER 3 (15) | FLUE GAS TEMPERATURE BOILER 4 °F. (16) | FLUE GAS BOILER °F. (17) | FLUE GAS BOILER 3 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | #4 o/s (22) | CWMU (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 200 | 1646 | | | 1646 | 204 | 1228 | 2980 | 63 | — | | 18680 | 7.4 | | | 422 | | | 374 | 6 | WB | 168 | 2900 |
| 2 | 200 | 1756 | | | 1756 | 197 | 2855 | 14970 | 52 | — | | 13870 | 7.4 | | | 422 | | | 375 | 6 | EB | 324 | 400 |
| 3 | 200 | 1760 | | | 1760 | 228 | 263 | 3620 | 58 | — | | 7820 | 7.4 | | | 422 | | | 373 | 6 | W | 35 | 300 |
| 4 | 200 | 1709 | | | 1709 | 228 | 422 | 2910 | 58 | — | | 11000 | 7.4 | | | 422 | | | 375 | 6 | DT | 56 | 200 |
| 5 | 200 | 1681 | | | 1681 | 207 | 681 | 10740 | 55 | — | | 13170 | 7.4 | | | 422 | | | 376 | 6 | W | 82 | 400 |
| 6 | 200 | 1568 | | | 1568 | 211 | 293 | 3600 | 65 | — | | 10400 | 7.4 | | | 422 | | | 375 | 6 | DT | 39 | 100 |
| 7 | 200 | 1506 | | | 1506 | 193 | 804 | 8380 | 68 | — | | 9140 | 7.4 | | | 422 | | | 375 | 6 | W | 106 | 200 |
| 8 | 200 | 1443 | | | 1443 | 199 | 208 | 15800 | 60 | — | | 11970 | 7.4 | | | 422 | | | 376 | 6 | JW | 20 | 300 |
| 9 | 200 | 1700 | | | 1700 | 222 | 710 | 8190 | 43 | — | | 14280 | 7.4 | | | 422 | | | 375 | 6 | EB | 54 | 300 |
| 10 | 200 | 1523 | | | 1523 | 173 | 2072 | 5600 | 43 | — | | 2520 | 7.4 | | | 422 | | | 375 | 6 | DT | 293 | 300 |
| 11 | 200 | 1707 | | | 1707 | 202 | 1821 | 203980 | 49° | | | 11230 | 7.4 | | | 422 | | | 375 | 6 | CCP | 240 | 300 |
| 12 | 200 | 1523 | | | 1523 | 196 | 1150 | 6200 | 59 | — | | 14310 | 7.4 | | | 422 | | | 375 | 6 | DT | 182 | 500 |
| 13 | 200 | 1475 | | | 1475 | 179 | 1304 | 1936 | 59 | — | | 12910 | 7.4 | | | 422 | | | 375 | 6 | DT | 122 | 300 |
| 14 | 200 | 1497 | | | 1497 | 197 | 514 | 11644 | 58 | — | | 9520 | 7.4 | | | 422 | | | 375 | 6 | DT | 68 | 500 |
| 15 | 200 | 1385 | | | 1385 | 178 | 700 | 10070 | 62 | — | | 12110 | 7.4 | | | 422 | | | 378 | 6 | [illegible] | 92 | 600 |
| 16 | 200 | 1362 | | | 1362 | 187 | 157 | 12130 | 59 | — | | 11250 | 7.4 | | | 422 | | | 375 | 6 | DT | 19 | 600 |
| 17 | 200 | 1400 | | | 1400 | 181 | 704 | 9690 | 66 | — | | 13110 | 7.4 | | | 422 | | | 375 | 6 | DT | 93 | 900 |
| 18 | 200 | 1407 | | | 1407 | 194 | 1007 | 8010 | 58 | — | | 9570 | 7.4 | | | 422 | | | 375 | 6 | [illegible] | -0- | 500 |
| 19 | 200 | 1414 | | | 1414 | 190 | 288 | 13950 | 55 | — | | 9070 | 7.4 | | | 422 | | | 378 | 6 | W | 38 | 500 |
| 20 | 200 | 1469 | | | 1469 | 185 | 966 | 41550 | 61 | — | | 8530 | 7.4 | | | 422 | | | 375 | 6 | [illegible] | 127 | 400 |
| 21 | 200 | 1372 | | | 1372 | 186 | 191 | 9250 | 69 | — | | 9400 | 7.4 | | | 422 | | | 376 | 6 | W | 25 | 600 |
| 22 | 200 | 1368 | | | 1368 | 174 | 876 | 8900 | 70 | 876 | | 13230 | 7.4 | | | 422 | | | 378 | 6 | JW | 108 | 1200 |
| 23 | 200 | 1328 | | | 1328 | 134 | 2865 | 8100 | 72 | 2865 | | 12560 | 7.4 | | | 422 | | | 380 | 6 | JW | 352 | 1800 |
| 24 | 200 | 1231 | | | 1231 | 108 | 3599 | 11060 | 63 | 3599 | | 14620 | 7.4 | | | 422 | | | 380 | 6 | [illegible] | 442 | 2400 |
| 25 | 200 | 1320 | | | 1320 | 131 | 3004 | 13900 | 59 | 3004 | | 11200 | 7.4 | | | 422 | | | 378 | 6 | W | 369 | 1900 |
| 26 | 200 | 1321 | | | 1321 | 161 | 1442 | 14320 | 59 | 1232 | | 13030 | 7.4 | | | 422 | | | 378 | 6 | [illegible] | 179 | 1500 |
| 27 | 200 | 1310 | | | 1310 | 180 | 22 | 7480 | 65 | — | | 11740 | 7.4 | | | 422 | | | 377 | 6 | W | 3 | 1100 |
| 28 | 200 | 1328 | | | 1328 | 182 | 30 | 14170 | 71 | — | | 12100 | 7.4 | | | 422 | | | 377 | 6 | [illegible] | 4 | 1900 |
| 29 | 200 | 1316 | | | 1316 | 180 | 67 | 4400 | 62 | | | 10120 | 7.4 | | | 422 | | | 378 | 6 | JW | 8 | 1100 |
| 30 | 200 | 1252 | | | 1252 | 168 | 246 | 15980 | 67 | — | | 8060 | 7.4 | | | 422 | | | 375 | 6 | DT | 31 | 700 |
| 31 | 200 | 1264 | | | 1264 | 158 | 897 | 16050 | 52 | — | | 14590 | 7.4 | | | 422 | | | 376 | 6 | ~ | 118 | 300 |
| TOTAL | 6200 | 46,611 | | | 45611 | 5723 | 30980 | 518870 | 1858 | 11576 | | 360940 | 229.4 | | | 13082 | | | 11625 | 186 | | 3831 | 25500 |
| MAXIMUM | 200 | 1760 | | | 1760 | 238 | 3599 | 203980 | 72 | 3599 | | 14690 | 7.4 | | | 422 | | | 380 | 6 | | 324 | 2900 |
| MINIMUM | 200 | 1231 | | | 1231 | 108 | 22 | 1936 | 43 | 1232 | | 7520 | 7.4 | | | 422 | | | 372 | 6 | | 3 | 100 |
| AVERAGE | 200 | 1471 | | | 1471 | 185 | 593 | 16916 | 60 | 2315 | | 11643 | 7.4 | | | 422 | | | 375 | 6 | | 124 | 823 |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 2060; OIL: 172; N.G. 21

REMARKS:

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: 54733 62752 4368 330 | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3967, 1 NOV 72 REPLACES DA FORM 5-86 1 JUN 56 WHICH WILL BE USED.

54733 ÷ 67491 = .81

A.

A.5-72

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is the Corps of Engineers.

INSTALLATION: Ft Stewart | PLANT: CEP | BLDG. NO.: 1412 | MONTH: FEB. 95

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 4 1,000 LB. (2) | BOILER 1/2 1,000 LB. (3) | BOILER 3 1,000 LB. (4) | TOTAL 1,000 LB. (5) | WOOD WATER TO BOILER 1,000 LB. (6) | #2 FUEL USED LB. M.C.F. GAL. (7) | NG (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. W/O (10) | TEMP. °F. (11) | MAKEUP GAL. (12) | % CO2 BOILER 4 (13) | BOILER 1 (14) | BOILER 3 (15) | FLUE GAS TEMPERATURE BOILER 4 °F. (16) | BOILER 1 °F. (17) | BOILER 3 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | #4 O/S (22) | CWMU (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 200 | 1860 | | | 1860 | 228 | 1545 | 16840 | 47° | -0- | | | 7HW | opr. | - | ~~400~~ | off. | - | 378 | 6 | CCP | 203 | 355 |
| 2 | 200 | 1740 | | | 1740 | [illegible] | 1325 | 10610 | 56 | 717 | | | 7.4 | | | 422 | | | 376 | 6 | EJ | 131 | 945 |
| 3 | 200 | ~~1634~~ | | | 1624 | 150 | 8100 | 35800 | 62 | 1987 | | 14990 | 7.4 | | | 422 | | | 376 | 6 | [illegible] | 244 | 340 |
| 4 | 200 | 1555 | | 223 | 1778 | 166 | 8550 | 20,100 | 49 | 28446 | | 16660 | 7.4 | | | 422 | | 420 | 376 | 6 | [illegible] | 346 | 10 |
| 5 | 200 | 898 | | 805 | 1703 | 94 | 9003 | 1900 | 44 | 1506 | | 16,630 | 7.4 | | | 422 | | 420 | 376 | 6 | DT | 215 | [illegible] |
| 6 | 200 | 954 | | 1014 | 1968 | 132 | 11,336 | 0 | 37 | — | | 12940 | | | | 422 | | 420 | 373 | 6 | W | [illegible] | 200 |
| 7 | 200 | 105 | 598 | 1108 | 1811 | 27 | 11250 | 361990 | 47 | — | | 17370 | #1 | 7.4 | 7.4 | ~~472~~ | 385 | 420 | 374 | 6 | W | — | 700 |
| 8 | 200 | [illegible] | 400/400 | 758 | 1558 | — | 11220 | 0 | 36 | — | | 17540 | 7.4 | 7.4 | 7.4 | [illegible] | 385 | 420 | 372 | 6 | [illegible] | — | |
| 9 | 200 | " | 500/500 | 948 | 1448 | — | 11305 | 0 | 35 | — | | 15240 | " | " | " | [illegible] | "/385 | 420 | 374 | 6 | DN | — | 760 |
| 10 | 200 | 70 | 500/500 | 870 | 1940 | 11 | 19745 | 0 | 50 | | | 17320 | 7.4 | 7.4 | 7.4 | 422 | 385 | 420 | 376 | 6 | W | 40 | 700 |
| 11 | 200 | 1640 | 180 | | 1820 | 196 | 1356 | 14880 | 58 | 1433 | | 15500 | 7.4 | 7.4 | | 428 | 385 | | 374 | 6 | W | 225 | 200 |
| 12 | 200 | 1862 | | | 1862 | 173 | 1621 | 4236 | 49 | 4737 | | 14720 | 7.4 | | | 422 | | | 373 | 6 | W | 597 | 300 |
| 13 | 200 | 1967 | | | 1967 | 242 | 1613 | 122,484 | 48 | 0 | | 11,426 | 7.4 | | | 428 | | | 374 | 6 | DT | 213 | 200 |
| 14 | 200 | 1957 | | | 1957 | 252 | 2001 | 3830 | 50 | — | | 18050 | 7.4 | | | 422 | | | 372 | 6 | W | 132 | 900 |
| 15 | 200 | 1919 | | | 1919 | 265 | 1989 | 11,640 | 59 | — | | 25150 | 7.4 | | | 422 | | | 374 | 6 | CCP | 131 | 800 |
| 16 | 200 | 1584 | | | 1584 | 219 | 1255 | 16,760 | 73 | — | | 14,280 | 7.4 | | | 422 | | | 376 | 6 | CCP | 37 | 330 |
| 17 | 200 | 1569 | | | 1569 | 205 | 1600 | 5700 | 64 | — | | 12,940 | 7.4 | | | 428 | | | 373 | 6 | TW | 80 | 270 |
| 18 | 200 | 1760 | | | 1760 | 222 | 1600 | 0 | 50 | — | | 11150 | 7.4 | | | 422 | | | 374 | 6 | W | 745 | 200 |
| 19 | 200 | 1854 | | | 1854 | 212 | 2402 | 15,380 | 44 | — | | 17920 | 7.4 | | | 422 | | | 374 | 6 | DT | 317 | 200 |
| 20 | 200 | 1858 | | | 1858 | 220 | 2000 | 27710 | 58 | — | | 11550 | 7.4 | | | 472 | | | 373 | 6 | W | 264 | 100 |
| 21 | 200 | 1849 | | | 1849 | 218 | 2004 | 38980 | 47 | — | | 15790 | 7.4 | | | 421 | | | [illegible] | 6 | DT | 264 | 300 |
| 22 | 200 | 2041 | | | 2041 | 281 | 1659 | 20080 | 39 | — | | 13680 | 7.4 | | | 422 | | | 373 | 6 | ER | 218 | 300 |
| 23 | 200 | 1949 | | | 1949 | 268 | 1259 | 30 | 48 | [illegible] | | 9050 | 7.4 | | | 422 | | | 373 | 6 | WR | 166 | 300 |
| 24 | 200 | 1891 | | | 1891 | 272 | 1542 | 17300 | 51 | [illegible] | | 6540 | 7.4 | | | 422 | | | 374 | 6 | W | 203 | 300 |
| 25 | 200 | 1970 | | | 1970 | 252 | 2020 | 0 | 47 | - | | 8290 | 7.4 | | | 422 | | | 374 | 6 | DT | 142 | 200 |
| 26 | 200 | 1851 | | | 1851 | 229 | 1407 | 15280 | 50 | | | 7870 | 7.4 | | | 412 | | | 376 | 6 | W | 186 | 300 |
| 27 | 200 | 326 | 1000 | | 1326 | 34 | 1581 | 403080 | 57 | - | | 24220 | 7.4 | | | 422 | 385 | | 376 | 6 | DT | 77 | 300 |
| 28 | 200 | 1819 | | | 1819 | 234 | 1930 | 80 | 65 | — | | 12030 | 7.4 | | | 422 | | | 373 | 6 | W | 122 | 800 |
| 29 | | | | | | | | | | | | | | | | | | | | | | | |
| 30 | | | | | | | | | | | | | | | | | | | | | | | |
| 31 | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | 5600 | 40372 | 3178/1440 | 5726 | 50776 | 5024 | 723592 | 1159730 | 1426 | 13181 | | 383346 | 192 | 37 | 296 | 10972 | 2310/1155 | 2940 | 10488 | 168 | | 14712 | 10,010 |
| MAXIMUM | 200 | 2041 | 1000/500 | 1108 | 2041 | 281 | 19,145 | 403080 | 73 | 4737 | | 25150 | 7.4 | 7.4 | 7.4 | 422 | 385/385 | 420 | 378 | 6 | | 597 | 945 |
| MINIMUM | 200 | 70 | 180/400 | 223 | 1326 | 11 | 1255 | 30 | 35 | 717 | | 6540 | 7.4 | 7.4 | 7.4 | 422 | 385/385 | 420 | 372 | 6 | | 40 | 10 |
| AVERAGE | 200 | 1557 | 230/467 | 818 | 1813 | 193 | 4,414 | 52716 | 51 | 2197 | | 14745 | 7.4 | 7.4 | 7.4 | 422 | 385 | 420 | 375 | 6 | | 669 | 385 |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 1 NOV 72 3967 REPLACES DA FORM 5-88 1 JUN 56 WHICH WILL BE USED.

A.5-73

FACILITIES ENGINEERING OPERATING LOG (*Boiler Plant*)

For use of this form, see AR 420-49; the proponent agency is the Corps of Engineers.

INSTALLATION: Ft. Stewart | PLANT: CEP | BLDG. NO.: 1412 | MONTH: JAN. 95

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 4 1,000 LB. (2) | BOILER 1 1,000 LB. (3) | BOILER 3 1,000 LB. (4) | TOTAL 1,000 LB. (5) | WOOD 1,000 LB. (6) | #2 FUEL USED (7) | NG PER UNIT (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. W/D (10) | TEMP. °F. (11) | MAKEUP GAL. (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 200 | | 800 | 1015 | 1815 | — | 9,253 | — | 53 | — | | 12340 |
| 2 | 200 | [illegible] | 800 | 1048 | 1848 | — | 9,253 | 50 | 50 | — | | 14200 |
| 3 | 200 | 353 | 800 | 700 | 1753 | 49 | [illegible] 724 | — | 46 | -0- | | 11070 |
| 4 | 200 | 1974 | — | — | 1974 | 230 | 2285 | 2480 | 41 | -0- | | 16470 |
| 5 | 200 | 1824 | — | — | 1824 | 231 | 1104 | 10140 | 37 | -0- | | 14790 |
| 6 | 200 | 1848 | — | — | 1848 | 239 | 810 | 9660 | 50 | — | | 8750 |
| 7 | 200 | 1550 | — | — | 1550 | 207 | 856 | 11362 | 56 | — | | 11670 |
| 8 | 200 | 1826 | — | — | 1826 | 249 | 1120 | 13280 | 42 | | | 11310 |
| 9 | 200 | 1896 | | | 1896 | 243 | 852 | 22760 | 48 | | | 10650 |
| 10 | 200 | 1792 | — | — | 1792 | 224 | 1220 | 7340 | 51 | | | 12070 |
| 11 | 200 | 1705 | | | 1705 | 220 | 809 | 1630 | 54 | -0- | | 8370 |
| 12 | 200 | 1592 | | | 1592 | 220 | 1415 | 19180 | 55 | -0- | | 10090 |
| 13 | 200 | 1512 | | | 1592 | 173 | 1980 | 56000 | 64 | 0 | | 15170 |
| 14 | 200 | 1430 | 108 | | 1538 | 180 | 720 | 90490 | 63 | — | | 13320 |
| 15 | 200 | 1185 | | 444 | 1629 | 152 | 591 | 132,320 | 68 | — | | 15450 |
| 16 | 200 | 1436 | | 234 | 1670 | 185 | 670 | 128,000 | 53 | | | 15060 |
| 17 | 200 | 1683 | | | 1683 | 203 | 1559 | 31240 | 54 | | | 15040 |
| 18 | 200 | 1734 | | | 1734 | 201 | 1427 | 27620 | 52 | 1781 | | 13900 |
| 19 | 200 | 1530 | | | 1530 | 138 | -0- | 80,070 | 59 | 4321 | | 17980 |
| 20 | 200 | 1837 | | | 1837 | 206 | — | 7560 | 49 | 2789 | | 14010 |
| 21 | 200 | 1842 | | | 1842 | 249 | 1241 | 1200 | 50 | — | | 9440 |
| 22 | 200 | 1810 | | | 1810 | 247 | 1120 | 13060 | 48 | — | | 12120 |
| 23 | 200 | 1712 | 60 | 50 | 1822 | 222 | 759 | 48300 | 46 | — | | 16140 |
| 24 | 200 | 1955 | | | 1955 | 246 | 730 | 57670 | 40 | — | | 13080 |
| 25 | 200 | 2004 | | | 2004 | 259 | 1403 | 17870 | 40 | | | 14830 |
| 26 | 200 | 1902 | — | — | 1902 | 212 | 1368 | 29360 | 46 | — | | 13280 |
| 27 | 200 | 1854 | | | 1854 | 250 | 1306 | 31500 | 52 | | | 14760 |
| 28 | 200 | 1434 | | 216 | 1650 | 195 | 470 | 70,700 | 60 | | | 11050 |
| 29 | 200 | 1565 | | 216 | 1781 | 200 | 895 | 83400 | 59 | | | 11390 |
| 30 | 200 | 1825 | | | 1825 | 237 | 1190 | 40,500 | 46 | | | 11220 |
| 31 | 200 | 1952 | | | 1952 | 243 | 1430 | 47,150 | 43 | | | 13900 |
| TOTAL | 6200 | 48612 | 2468 | 3923 | 55003 | 6,100 | 48592 | 1,027,800 | 1565 | 8891 | | 403,424 |
| MAXIMUM | 200 | 2004 | 800 | 1048 | 2004 | 259 | 9,253 | 132,320 | 64 | 4321 | | 17980 |
| MINIMUM | 200 | 353 | 60 | 50 | 1512 | 49 | 591 | 50 | 37 | 1781 | | 8370 |
| AVERAGE | 200 | 1676 | 494 | 490 | 1774 | 210 | 1675 | 35442 | 50 | 2963 | | 13013 |

| DATE | % $CO_2$ BOILER 4 (13) | BOILER 1 (14) | BOILER 3 (15) | FLUE GAS TEMPERATURE BOILER 4 °F. (16) | BOILER 1 °F. (17) | BOILER 3 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | #4 O/S (22) | CWMV (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | — | 11 | 11 | 420 | 420 | 420 | 380 | | DR | — | 1300 |
| 2 | — | 11 | 11 | 420 | 420 | 420 | 380 | | DR | — | 700 |
| 3 | 11 | 11 | 11 | 420 | 420 | 420 | 380 | | ZH | 96 | 200 |
| 4 | 11 | — | — | 420 | — | — | 380 | | EP | 301 | 1100 |
| 5 | 11 | 11 | 11 | 420 | — | — | 380 | | CCP | 146 | 800 |
| 6 | 11 | — | — | 420 | — | — | 380 | | DR | 107 | 1200 |
| 7 | 11 | — | — | 420 | — | — | 380 | | ZH | 47 | 1200 |
| 8 | 11 | — | — | 420 | — | — | 380 | | DR | 16 | 400 |
| 9 | 11 | — | — | 420 | — | — | 380 | | TH | 61 | 400 |
| 10 | 11 | — | — | 420 | — | — | 380 | | DR | 161 | 1200 |
| 11 | 11 | — | — | 420 | — | — | 380 | | EF | 107 | 500 |
| 12 | 11 | — | — | 420 | | | 380 | | CCP | 55 | 500 |
| 13 | 11 | — | — | 420 | — | — | 380 | | TH | 260 | 1500 |
| 14 | 11 | — | — | 420 | — | — | 380 | | DR | 95 | 300 |
| 15 | 11 | | 11 | 420 | | 420 | 380 | | ZH | 78 | 400 |
| 16 | 11 | | 11 | 460 | | 420 | 380 | | ZH | 88 | 600 |
| 17 | 11 | | — | 460 | | — | 380 | | TH | 206 | 700 |
| 18 | 11 | | 11 | 460 | | 420 | 380 | | EJ | 275 | 1100 |
| 19 | 11 | | 11 | 460 | | 420 | 380 | | CCP | 530 | 1570 |
| 20 | 11 | | 11 | 460 | | 420 | 380 | | DR | 342 | 300 |
| 21 | 11 | | — | 420 | | | 380 | | ZH | 31 | 100 |
| 22 | 11 | — | — | 460 | | | 380 | | DR | 16 | 100 |
| 23 | | | | 460 | 420 | 420 | 380 | | ZH | 106 | 100 |
| 24 | | | | 460 | | | 380 | | DR | 97 | 0 |
| 25 | | | | 460 | | | 380 | | EJ | 54 | 100 |
| 26 | | | | 460 | | | 380 | | CCP | 49 | -0- |
| 27 | | | | 460 | | | 380 | | ZH | 41 | 200 |
| 28 | | | | 460 | | | 380 | | ZH | 62 | 600 |
| 29 | | | | 460 | | | 380 | | DT | 118 | 800 |
| 30 | | | | 460 | | | 380 | | ZH | 157 | 300 |
| 31 | | | | 460 | | | 380 | | DR | 189 | 200 |
| TOTAL | | | | 13280 | 1680 | 3780 | 11780 | | | 3891 | 18470 |
| MAXIMUM | | | | 480 | 420 | 420 | 380 | | | 530 | 1570 |
| MINIMUM | | | | 420 | 420 | 420 | 380 | | | 16 | 100 |
| AVERAGE | | | | 428 | 420 | 420 | 380 | | | 134 | 636 |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 5-98 1 JUN 55 WHICH WILL BE USED.

A.5-74

## FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is the Corps of Engineers.

INSTALLATION: FT. STEWART | PLANT: CEP | BLDG. NO.: 1412 | MONTH: Dec 94

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 4 1,000 LB. (2) | BOILER 2 1,000 LB. (3) | BOILER 3 1,000 LB. (4) | TOTAL 1,000 LB. (5) | FEED WATER TO BOILER 1,000 LB. (6) | No. 2 FUEL USED GAL. (7) | N.G. (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. W/O (10) | FEEDWATER HEATER TEMP. °F. (11) | MAKEUP GAL. (12) | CO, BOILER 4 (13) | CO, BOILER 2 (14) | CO, BOILER 3 (15) | FLUE GAS TEMPERATURE BOILER 4 °F. (16) | BOILER 2 °F. (17) | BOILER 3 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | NO. 4 O/S (22) | CWMU (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 200 | 1324 | | | 1324 | 231 | 1548 | 43100 | 49 | 3029 | 220 | 16310 | 11 | | | 435 | | | 382 | 6 | OHP | 372 | 5700 |
| 2 | 200 | 1775 | | | 1775 | 288 | 1548 | 25650 | 59 | 2447 | 220 | 17950 | | | | 435 | | | 380 | 6 | DT | 300 | 5100 |
| 3 | 200 | 1276 | | | 1276 | 220 | 821 | 30710 | 63° | — | 220 | 12720 | 11 | | | 435 | | | 381 | 6 | ELB | 43 | 4700 |
| 4 | 200 | 1134 | | | 1134 | 259 | 831 | 44010 | 70 | — | 220 | 13390 | | | | 435 | | | 381 | 6 | DT | 44 | 4400 |
| 5 | 200 | 1186 | | | 1186 | 214 | 736 | 74500 | 69° | 2129 | 220 | 16600 | | | | 435 | | | 386 | 6 | An | 359 | 4200 |
| 6 | 200 | 1315 | | | 1315 | 182 | 1548 | 13350 | 67° | 3029 | 220 | 18870 | | | | 435 | | | 380 | 6 | An | 372 | 3700 |
| 7 | 200 | 1397 | | | 1397 | 176 | 1092 | 18150 | 62 | 883 | 220 | 10970 | | | | 435 | | | 380 | 6 | EZ | 122 | 3900 |
| 8 | 200 | 1349 | | | 1349 | 181 | 1278 | 20080 | 63 | — | 220 | 11670 | | | | 435 | | | 380 | 6 | OHP | 37 | 3900 |
| 9 | 200 | 1411 | | | 1411 | 188 | 355 | 20300 | 60° | — | 220 | 10380 | | | | 434 | | | 379 | 6 | ELB | 47 | 1600 |
| 10 | 200 | 1400 | | | 1400 | 193 | 1049 | 6990 | 62 | — | 220 | 14540 | | | | 435 | | | 380 | 6 | An | 7 | 0 |
| 11 | 200 | 1518 | | | 1518 | 199 | 598 | 8950 | 53 | — | 220 | 11660 | | | | 435 | | | 380 | 6 | An | 79 | 0 |
| 12 | 200 | 1654 | | | 1654 | 228 | 401 | 34100 | 43 | — | 220 | 15560 | | | | 435 | | | 380 | 6 | An | 53 | 700 |
| 13 | 200 | 1810 | | | 1810 | 229 | 1145 | 23040 | 46 | — | 220 | 8080 | | | | 434 | | | 377 | 6 | ELB | 151 | 200 |
| 14 | 200 | 1680 | | | 1680 | 232 | 457 | 17260 | 47 | | 220 | 10740 | 11 | | | 435 | | | 375 | 6 | W | 61 | 1100 |
| 15 | 200 | 1727 | | | 1727 | 226 | 725 | 21840 | 51 | — | 220 | 10810 | | | | 435 | | | 375 | 6 | DT | 96 | 400 |
| 16 | 200 | 1767 | | | 1767 | 230 | 751 | 22000 | 47 | — | 220 | 13500 | 11 | | | 435 | | | 375 | 6 | GHP | 99 | 300 |
| 17 | 200 | 1649 | | | 1649 | 223 | 1256 | 18880 | 49 | — | 220 | 10170 | | | | 435 | | | 375 | 6 | ELB | 34 | 300 |
| 18 | 200 | 1589 | | | 1589 | 219 | 1243 | 14960 | 52 | — | 220 | 10410 | | | | 435 | | | 375 | 6 | DT | 32 | 300 |
| 19 | 200 | 1767 | | | 1767 | 237 | 362 | 25530 | 43° | — | 220 | 10490 | | | | 434 | | | 374 | 6 | ELB | 48 | 100 |
| 20 | 200 | 1774 | | 136 | 1774 | 245 | 1102 | 13660 | 48 | — | 220 | 19250 | | | | 435 | | | 375 | 6 | An | 14 | 2100 |
| 21 | 200 | 1724 | | 198 | 1922 | 221 | 570 | 73920 | 49 | 895 | 220 | 19410 | 11 | | | 435 | | | 375 | 6 | [illegible] | 1214 | 2700 |
| 22 | 200 | 1454 | | 571 | 2025 | 160 | 436 | 242370 | 49 | 1943 | 220 | 15300 | | | | 425 | | | 377 | 6 | W | 297 | 2200 |
| 23 | 200 | 1550 | | 362 | 1912 | 211 | 1157 | 224630 | 46 | — | 220 | 7830 | | | | 435 | | | 377 | 6 | ELB | 80 | 1000 |
| 24 | 200 | 1592 | | 181 | 1773 | 200 | 1065 | 138300 | 52 | | 220 | 10840 | | | | 435 | | | 376 | 6 | ZH | 141 | 800 |
| 25 | 200 | 1784 | | | 1784 | 233 | 700 | 14200 | 48 | — | 220 | 12690 | | | | 435 | | | 374 | 6 | An | 93 | 1400 |
| 26 | 200 | 1713 | | | 1713 | 232 | 1213 | 2900 | 52 | | 220 | 5980 | | | | 435 | | | 375 | 6 | BH | 28 | 1000 |
| 27 | 200 | 1756 | | | 1756 | 218 | 1500 | 21300 | 51 | 1929 | 220 | 17900 | | | | 435 | | | 375 | 6 | [illegible] | 237 | 1300 |
| 28 | 200 | 1636 | | | 1636 | 175 | 1596 | 7130 | 51 | 2965 | 220 | 16480 | | | | 435 | | | 375 | 6 | EF | 364 | 1700 |
| 29 | 200 | 803 | | 597 | [illegible] | 195 | 1548 | 17040 | 54 | 947 | 220 | 20,800 | | | | 435 | | | 375 | 6 | CCP | 116 | 1500 |
| 30 | 200 | | | 1400 | 1400 | 143 | 1500 | 5150 | 54 | — | 220 | 9500 | | | | | | 435 | 370 | 6 | | — | 600 |
| 31 | 200 | | | 1796 | 1796 | 243 | 1596 | 122690 | 49 | — | 220 | 14520 | | | | | | 435 | 375 | 6 | An | — | 1100 |
| TOTAL | 6200 | 44,514 | | 5105 | 49169 | 6631 | 31,727 | 1,366,090 | 1660 | 20196 | 6820 | 419160 | | | | 12612 | | 870 | 11691 | 186 | | 3790 | 58000 |
| MAXIMUM | 200 | 1784 | | 1796 | 2025 | 257 | 1596 | 242,370 | 70 | 3029 | 220 | 20800 | | | | 435 | | 435 | 382 | 6 | | 372 | 5200 |
| MINIMUM | 200 | 803 | | 181 | 1134 | 160 | 355 | 2900 | 43 | 883 | 220 | 7830 | | | | 434 | | 435 | 370 | 6 | | 7 | 100 |
| AVERAGE | 200 | 1534 | | 729 | 1600 | 214 | 1024 | 44068 | 53 | 2019 | 220 | 13521 | | | | 434 | | 435 | 377 | 6 | | 130 | 2000 |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 5-99, 1 JUN 56, WHICH WILL BE USED.

A.5-75

## ACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is the Corps of Engineers.

LATION: Ft Stewart | PLANT: CEP | BLDG. NO. 1412 | MONTH: Nov 94

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 4 1,000 LB. (2) | BOILER 2 1,000 LB. (3) | BOILER 3 1,000 LB. (4) | TOTAL 1,000 LB. (5) | Wood 1,000 LB. (6) | No 2 FUEL OIL (7) | NG (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER W-O.O (10) | FEEDWATER HEATER TEMP. °F. (11) | MAKEUP GAL. (12) | % $CO_2$ BOILER 1 (13) | % $CO_2$ BOILER 4 (14) | % $CO_2$ BOILER 3 (15) | FLUE GAS TEMPERATURE BOILER 4 °F. (16) | FLUE GAS TEMPERATURE BOILER 2 °F. (17) | FLUE GAS TEMPERATURE BOILER 3 °F. (18) | TEMP. H.W. SUPPLY °F (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | #4 BLR O/S (22) | CWMU (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 300 | 1188 | | | 1188 | 150 | 2775 | 43100 | 61 | 705 | | 4120 | | 7.5 | | 421 | | | 365 | 6 | ET | 96 | 5200 |
| 2 | 200 | 1218 | | | 1218 | 168 | 2077 | 70570 | 55 | 4? | | 1910 | | 7.4 | | 422 | | | 365 | 6 | DT | 10 | 10300 |
| 3 | 200 | 1256 | | | 1256 | 172 | 2757 | 90 | 60 | — | | 13180 | | 7.4 | | 422 | | | 365 | 6 | MW | 100 | 9700 |
| 4 | 200 | 1248 | | | 1248 | 160 | 2612 | 42830 | 65 | - | | 16220 | | 7.4 | | 422 | | | 365 | 6 | CCP | 81 | 10,400 |
| 5 | 200 | 1241 | | | 1241 | 164 | 350 | 4962 | 70 | | | 15080 | | 7.4 | | 422 | | | 365 | 6 | PK | 86 | 9100 |
| 6 | 200 | 1188 | | | 1188 | 160 | 212 | 38220 | 74° | | | 14900 | | 7.5 | | 421 | | | 365 | 6 | SCP | 28 | 9800 |
| 7 | 200 | 1178 | | | 1178 | 151 | 348 | 43600 | 65° | | | 12210 | | 7.5 | | 421 | | | 365 | 6 | EZ | 46 | 9000 |
| 8 | 200 | 1177 | | | 1177 | 159 | 171 | 25,260 | 64° | | | 15,360 | | 7.5 | | 421 | | | 365 | 6 | CP | 23 | 9200 |
| 9 | 200 | 1190 | | | 1190 | 164 | 215 | 19,510 | 70 | | | 18,450 | | 7.5 | | 421 | | | 365 | 6 | DT | 28 | 18400 |
| 10 | 200 | 1100 | | 100 | 1200 | 151 | 1020 | 56130 | 73 | | | 16470 | | 7.5 | 7.6 | 424 | | 420 | 372 | 6 | DT | 135 | 11800 |
| 11 | 200 | 1073 | | 379 | 1452 | 147 | 571 | 230410 | 54 | 1412 | | 13860 | | 7.5 | 7.6 | 421 | | 420 | 370 | 6 | W | 248 | 10100 |
| 12 | 200 | 1298 | | | 1298 | 131 | 3500 | 6320 | 57 | 2777 | | 14480 | | 7.4 | | 422 | | | 370 | 6 | Rn | 341 | 11500 |
| 13 | 200 | 1433 | | | 1433 | 156 | 3500 | 11830 | 59 | 2394 | | 13250 | | 7.4 | | 422 | | | 370 | 6 | Rn | 294 | 11400 |
| 14 | 200 | 1415 | | | 1415 | 152 | 1618 | 8900 | 65 | 2567 | | 19840 | | 7.4 | | 422 | | | 368 | 6 | EF | 315 | 9500 |
| 15 | 200 | 1391 | | | 1391 | 157 | 2948 | 22210 | 67° | 2034 | | 22030 | | 7.4 | | 422 | | | 368 | 6 | Rn | 250 | 8200 |
| 16 | 200 | 1248 | | | 1248 | 136 | 2025 | 56800 | 63 | 2092 | | 11030 | | 7.4 | | 422 | | | 374 | 6 | W | 261 | 18000 |
| 17 | 200 | 1366 | | | 1366 | 183 | 308 | 31910 | 57 | — | | 23010 | | 7.4 | | 422 | | | 374 | 6 | RR | 41 | 7200 |
| 18 | 200 | 1353 | | | 1353 | 180 | 373 | 14960 | 64 | — | | 12,580 | | 7.4 | | 422 | | | 373 | 6 | ELB | 50 | 7600 |
| 19 | 200 | 1265 | | | 1265 | 175 | 294 | 21280 | 66 | — | | 18870 | | 7.4 | | 422 | | | 372 | 6 | DR | 39 | 9200 |
| 20 | 200 | 1315 | | | 1315 | 180 | 2081 | 32080 | 61 | — | | R640 | | 7.4 | | 422 | | | 373 | 6 | ELB | 11 | 14700 |
| 21 | 200 | 989.0 | | 266.0 | 1,255 | 137 | 2254 | 9210 | 71° | — | | 14180 | | 7.6 | 7.6 | 420 | | 420 | 374 | 6 | DR | 285 | 5800 |
| 22 | 200 | 1213 | | | 1213 | 161 | 327 | 37060 | 66° | — | | 17650 | | 7.4 | | 422 | | | 373 | 6 | ELB | 43 | 8900 |
| 23 | 200 | 1261 | | | 1261 | 154 | 1078 | 77830 | 53 | — | | 18870 | | 7.4 | | 422 | | | 373 | 6 | Rn | 142 | 6800 |
| 24 | 200 | 1312 | | | 1312 | 170 | 600 | -70 | 44 | — | | 13450 | | 7.4 | | 422 | | | 374 | 6 | EZ | 79 | 6800 |
| 25 | 200 | 1312 | | | 1312 | 181 | 229 | 27300 | 53 | — | | 12510 | | 7.4 | | 422 | | | 374 | 6 | L.R. | 31 | 2600 |
| 26 | 200 | 1347 | | | 1347 | 181 | 261 | 4910 | 54 | — | | 13890 | | 7.4 | | 422 | | | 374 | 6 | Rn | 34 | 7300 |
| 27 | 200 | 1300 | | | 1300 | 179 | 102 | 23140 | 65 | — | | 12370 | | 7.4 | | 422 | | | 374 | 6 | Rn | 13 | 8500 |
| 28 | 200 | 1194 | | | 1194 | 136 | 1533 | 20340 | 72 | — | | 14820 | | 7.5 | | 421 | | | 375 | 6 | ELB | 202 | 10200 |
| 29 | 200 | 1210 | | | 1210 | 167 | 2071 | 26950 | 65 | 1167 | | 13580 | | 7.4 | | 422 | | | 374 | 6 | DR | 152 | 9200 |
| 30 | 200 | 1231 | | | 1231 | 127 | 1000 | 29610 | 54 | 2532 | | 16470 | | 7.4 | | 422 | | | 378 | 6 | W | 311 | 8900 |
| 31 | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | 6000 | 37510 | | 745 | 38255 | 5000 | 54096 | 1082030 | 1867 | | | 442980 | | 223.0 | 22.8 | 12610 | | 1260 | 11112 | 180 | | | |
| MAXIMUM | 200 | 1433 | | 379 | 1452 | 183 | 3500 | 230410 | 74 | | | 23010 | | 7.6 | 7.6 | 422 | | 420 | 378 | 6 | | | |
| MINIMUM | 200 | 989 | | 100 | 1177 | 127 | 102 | 70 | 44 | | | 1910 | | 7.4 | 7.6 | 420 | | 420 | 365 | 6 | | | |
| AVERAGE | 200 | 1250 | | 248 | 1275 | 167 | 1803 | 36068 | 62 | | | 14766 | | 7.4 | 7.6 | 421 | | 420 | 370 | 6 | | | |

EVAPORATION LB. STEAM PER LB. STD. FUEL: 6000 | 37510 | 745

FUEL USED DURING MONTH (STANDARD TONS) 23: 38,255 | 4794 | 11,840 | 1,038,930 | 1867 | 17680

REMARKS: 442,980 | 223 | 22.8 | 12610 | 1260 | 11,112 | 180 | 3735 | 290300

SEE REVERSE SIDE FOR INSTRUCTIONS 3

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 5-98 1 JUN 58, WHICH WILL BE USED.

A.5-76

+1200
7.4 422
-1200
7.5 421
#3
7.6
420

# FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is the Corps of Engineers.

INSTALLATION: Ft. Stewart | PLANT: C.E.P | BLDG. NO. 1412 | MONTH: Oct. 94

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 4 1,000 LB. (2) | BOILER 2 1,000 LB. (3) | BOILER 3 1,000 LB. (4) | TOTAL 1,000 LB. (5) | Wood / WATER TO BOILER 1,000 LB. (6) | FUEL USED GAL. Oil (7) | N.G. EVAP. LB. PER UNIT (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. (10) | FEEDWATER HEATER TEMP. °F. (11) | MAKEUP GAL. (12) | % CO2 BOILER 4 (13) | % CO2 BOILER 4 (14) | % CO2 BOILER 3 (15) | FLUE GAS TEMPERATURE BOILER 4 °F. (16) | FLUE GAS BOILER 2 °F. (17) | FLUE GAS BOILER 3 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | # 4 BLR O/S (22) | Cwmu (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 200 | 1244 | | | 1244 | 166 | 287 | 8170 | 73 | 3 | 223 | 7050 | | 11 | | 420 | | | 384 | 6 | E.7 | 38 | 2600 |
| 2 | 200 | 1248 | | | 1248 | 165 | 400 | 30 | 73 | 3 | 217 | 9190 | | 11 | | 420 | | | 384 | 6 | CP | 53 | 3200 |
| 3 | 200 | 1321 | | | 1321 | 127 | W.O.3223 | -30 | 71 | 3 | 222 | 10,300 | | 11 | | 420 | | | 383 | 6 | E7 | 402 | 2800 |
| 4 | 200 | 965 | | | 965 | 85 | 2864 | 30 | 63 | 3 | 222 | 6730 | | 11 | | 420 | | | 384 | 6 | CCP | 352 | 2600 |
| 5 | 200 | 1401 | | | 1401 | 142 | | 30 | 64 | 3 | 224 | 8520 | | 11 | | 420 | | | 384 | 6 | MW | 123 | 2700 |
| 6 | 200 | 1443 | | | 1443 | 149 | 550 | 0 | 67 | 3 | 220 | 12,550 | | 11 | | 420 | | | 384 | 6 | DT | 23 | 2800 |
| 7 | 200 | 1373 | | | 1373 | 135 | 203 | 20 | 66 | 3 | 220 | 11,210 | | 11 | | 420 | | | 383 | 6 | E7 | 27 | 2600 |
| 8 | 200 | 1383 | | | 1383 | 136 | 268 | 110,000 | 68 | 3 | 220 | 10,010 | | 11 | | 420 | | | 384 | 6 | CCP | 35 | 2600 |
| 9 | 200 | 1406 | | | 1406 | 135 | 458 | 10 | 76 | 3 | 220 | 9920 | | 11 | | 420 | | | 385 | 6 | E7 | 60 | 2600 |
| 10 | 200 | 1295 | | | 1295 | 155 | WO/1341 | 60 | 75 | 3 | 220 | 9460 | | 11 | | 420 | | | 385 | 6 | CP | 168 | 2700 |
| 11 | 200 | 1416 | | | 1416 | 137 | WO/3308 | -0- | 35 | 3 | 220 | 2120 | | 11 | | 420 | | | 385 | 6 | E2 | 421 | 2900 |
| 12 | 200 | 1427 | 420 7.4 | 114 | 1541 | .146 | WO 2090 | 0 | 60 | 3 | 220 | 900 | | | | 420 | | | 385 | 6 | DT | 257 | 3150 |
| 13 | 200 | 1281 | | 492 | 1773 | .127 | 81 | 25040 | 68 | 3 | 220 | 1600 | | 11 | | 420 | | | 385 | 6 | DT | 81 | 1600 |
| 14 | 200 | 1618 | | 364 | 1982 | .106 | 922 | 188620 | 70.5 | 3 | 220 | 1260 | | 11 | | 420 | | | 385 | 6 | CP | 122 | 2500 |
| 15 | 200 | 1839 | | | 1839 | .141 | 683 | 4570 | 62 | 3 | 223 | 3460 | | 11 | | 420 | | | 382 | 6 | W | 90 | 3100 |
| 16 | 200 | 1850 | | | 1850 | .226 | 1614 | 0 | 61.5 | 3 | 223 | 2470 | | 11 | | 420 | | | 385 | 6 | CP | 213 | 3200 |
| 17 | 220 | 1844 | | | 1844 | .120 | 1902 | 57550 | 60 | 3 | 223 | 1840 | | 11 | | 420 | | | 383 | 6 | W | 251 | 2600 |
| 18 | 200 | 1823 | | | 1823 | .115 | 2010 | -0- | 60.5 | 3 | 223 | 2330 | | 11 | | 420 | | | 385 | 6 | CP | 266 | 2300 |
| 19 | 200 | 1459 | | 209 | 1668 | .101 | 2755 | 9770 | 68 | 3 | 223 | 2144 | | 11 | | 420 | | | 365 | 6 | DT | 364 | 2200 |
| 20 | 200 | 1363 | | | 1363 | .138 | 828 | | 74 | 3 | 223 | 1900 | | 11 | | 420 | | | 365 | 6 | MW | 110 | 2000 |
| 21 | 200 | 1328 | | | 1328 | .124 | 506 | 3100 | 74 | 3 | 223 | 1730 | | 11 | | 420 | | | 365 | 6 | CCP | 67 | 2000 |
| 22 | 200 | 1305 | | | 1305 | .123 | 404 | -0- | 74 | 3 | 223 | 3020 | | 11 | | 420 | | | 365 | 6 | E7 | 54 | 1900 |
| 23 | 200 | 1265 | | | 1265 | .124 | 42 | -0- | 73 | 3 | 223 | 1390 | | 11 | | 420 | | | 365 | 6 | CCP | 6 | 2100 |
| 24 | 200 | 1286 | | | 1286 | 169 | 471 | -0- | 69 | 3 | 223 | 2520 | | 11 | | 420 | | | 365 | 6 | E.7 | 63 | 2000 |
| 25 | 200 | 1256 | | | 1256 | 160 | 254 | 7390 | 70 | 3 | 223 | 1950 | | 11 | | 420 | | | 365 | 6 | CP | 100 | 2000 |
| 26 | 200 | 800 | | 467 | 1267 | 110 | | 48800 | 66 | 3 | 223 | 2220 | | 11 | | 420 | | | 365 | 6 | MW | | 1600 |
| 27 | 200 | 800 | | 504 | 1304 | 110 | | — | 55 | 3 | 223 | 1830 | | | | 420 | | 420 | 365 | | MW | | 2800 |
| 28 | 200 | | 7.3 421 | 1008 | 1008 | -0- | 554 | 134,990 | 54 | 3 | 223 | 1870 | | 11 | | | | 420 | 365 | 6 | E4 | -0- | 2500 |
| 29 | 200 | 1153 | WO | 1419 | 1153 | 134 | 1508 | 10 | 62.5 | 3 | 223 | 2140 | | 11 | | 420 | | | 365 | 6 | CP | 186 | 2400 |
| 30 | 200 | 1166 | WO | 2877 | 1166 | 110 | 2899 | -0- | 62 | 3 | 223 | 750 | | 11 | | 420 | | | 365 | 6 | E7 | 354 | 2400 |
| 31 | 200 | 1146 | WO | 3369 | 1146 | 101 | 3369 | 10 | 74 | 3 | 223 | 2500 | | 11 | | 420 | | | 365 | 6 | CP | 413 | 1910 |
| TOTAL | 6200 | 40504 | | 3158 | 43662 | 3949 | 35802 | 598230 | 2064 | | | 136,384 | | | | | | | 11160 | 190 | | | 76362 |
| MAXIMUM | 200 | 1850 | | 1008 | 1982 | 169 | 3369 | 188620 | 76 | | | 12,550 | | | | | | | 385 | | | | |
| MINIMUM | 200 | 800 | | 114 | 1008 | 85 | 42 | 10 | 54 | | | 900 | | | | | | | 365 | | | | |
| AVERAGE | 200 | 1306.5 | | 452 | 1408.4 | 132 | 1279 | 29,912 | 66 | | | 4400 | | | | | | | 376 | | | | 2463 |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS: * No.2 OIL 17,027 ; Reclaimed OIL 18,775

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 5-88, 1 JUN 58, WHICH WILL BE USED.

965 7.5 421

420

1200+ 7.4 422

A.5-77

# ACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is the Corps of Engineers.

INSTALLATION: FT STEW | PLANT: CEP | BLDG. NO. 1412 | MONTH: SEP '94'

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 4 1,000 LB. (2) | BOILER 2 1,000 LB. (3) | BOILER 3 1,000 LB. (4) | TOTAL 1,000 LB. (5) | ~~FEED WATER TO BOILER~~ WOOD 1,000 LB. (6) | OIL- FUEL USED LB. M.C.F. GAL. * (7) | NG ~~EVAP. LB. PER UNIT~~ (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. (10) | FEEDWATER HEATER TEMP. °F. (11) | MAKEUP GAL. (12) | % CO2 BOILER 1 (13) | % CO2 BOILER 4 (14) | % CO2 BOILER 3 (15) | FLUE GAS TEMPERATURE BOILER 1 °F. (16) | FLUE GAS BOILER 4 °F. (17) | FLUE GAS BOILER 3 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | #4 BLR O/S (22) | CWMU (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 200 | 2015 | | | 2015 | 222 | 345 | 0 | 82 | 3 | 223 | 6740 | | 11 | | | 430 | | 382 | 6 | 2d | 46 | 3300 |
| 2 | 200 | 1952 | | | 1952 | 258 | 556 | 4170 | 91 | 3 | 223 | 10850 | | 11 | | | 430 | | 382 | 6 | ✓ | | 3100 |
| 3 | 200 | 1610 | | | 1610 | 214 | 430 | 7050 | 84 | 3 | 225 | 7990 | | 11 | | | 430 | | 384 | 6 | DT | 57 | 3100 |
| 4 | 200 | 1596 | | | 1596 | 186 | 120 | ø | 71 | 3 | 225 | 7390 | | 11 | | | 430 | | 314 | 6 | DT | | 2900 |
| 5 | 200 | ~~1400~~ | | 200 | 1600 | 156 | — | 8550 | 73 | 3 | 225 | 5060 | | 11 | | | 43 | | 384 | 6 | DT | 274 | 2900 |
| 6 | [illegible] | 1549 | | 200 | 1749 | 196 | 300 | 108930 | 78 | 3 | 223 | 17800 | | 11 | | | 430 | | 382 | 6 | [illegible] | | 3000 |
| 7 | 200 | 1672 | | 200 | 1872 | 209 | 126 | 139290 | 77 | 3 | 223 | 9440 | | 11 | | | 430 | | 382 | 6 | | 151 | 1900 |
| 8 | 200 | 1878 | | | 1878 | 241 | 954 | — | 78 | 3 | 223 | 10420 | | 11 | | | 430 | | 384 | 6 | mw | 125 | 2700 |
| 9 | 220 | 2003 | | | 2063 | 275 | 1430 | - | 75 | 3 | 223 | 8540 | | 11 | | | 1120 | | 383 | 6 | ✓ | 188 | 2700 |
| 10 | 220 | 1158 | | 458 | 1588 | 119 | 2640 | ✓ | 78 | 3 | 225 | 8200 | | 11 | | | 436 | | 383 | 6 | | 269 | 2800 |
| 11 | 220 | 2025 | | | 2025 | 267 | 1731 | — | 76 | 3 | 223 | 8060 | | 11 | | | 1130 | | 382 | 6 | [illegible] | 23? | 3900 |
| 12 | 220 | 277 | | 1306 | 1583 | ø | 9222 | ✓ | 77 | 3 | 224 | 8320 | | " | | | 430 | | 383 | 6 | DT | 277 | 1700 |
| 13 | 220 | | | 1147 | 1147 | — | 8700 | 330 | 74 | 3 | 223 | 5600 | | ~~11~~ | 11 | | 41? | 430 | 383 | 3 | ✓ | — | 2800 |
| 14 | 200 | 260 | | 77.8 | 1038 | 27 | 8500 | 500 | 76 | 3 | 223 | 2070 | | 11 | 11 | | 4 | 430 | 383 | 3 | [illegible] | 65 | 2900 |
| 15 | 206 | 1199 | | | 1199 | 148 | 920 | 0 | 80 | 3 | 223 | 6840 | | 11 | | | 430 | | 383 | 3 | RP | 121 | 2700 |
| 16 | 200 | 1275 | | | 1275 | 146 | 112 | 0 | 86 | 3 | 223 | 6990 | | — | | | — | | 382 | 3 | ✓ | 16 | 2600 |
| 17 | 200 | 1276 | | | 1276 | 17? | [illegible] | 0 | 78 | .. | [illegible] | 7050 | | - | | | - | | 381 | . | | 35 | 2?00 |
| 18 | 200 | 1342 | | | 1342 | 18? | ø | 0 | 78 | 3 | 222 | 6980 | | - | | | 426 | | 380 | 3 | DT | | 3000 |
| 19 | 200 | 1331 | | | 1331 | 240 | 268 | 3750 | 71 | 3 | 222 | 9150 | | 11 | | | 420 | | 382 | . | [illegible] | 36 | 3000 |
| 20 | 200 | 1348 | | | 1348 | 178 | 2425 | 8 | 76 | 3 | 225 | 8690 | | 11 | | | 420 | | 382 | 3 | DT | 70 | 3100 |
| 21 | 200 | 1366 | | | 1366 | 171 | 924 | 8. | 72 | 3 | 225 | 8030 | | 11 | | | 420 | | 380 | 3 | [illegible] | 121 | 3200 |
| 22 | 200 | 1274 | | | 1274 | 167 | 441 | 5666 | 72 | 3 | 225 | 9870 | | 11 | | | 4?? | | 384 | 6 | [illegible] | 58 | 2700 |
| 23 | 200 | 1258 | | | 1358 | 187 | 297 | 10 | 73 | 3 | 225 | 9440 | | 11 | | | 420 | | 385 | 6 | RN | 39 | 2800 |
| 24 | 200 | 1378 | | | 1378 | 179 | 551 | 10 | 72 | 3 | 225 | 9970 | | 11 | | | 420 | | 384 | 6 | [illegible] | 72 | [illegible] |
| 25 | 200 | 1305 | | | 1305 | 179 | wo 3616 | 0 | 80 | 3 | 223 | 1390 | | 11 | | | 420 | | 385 | 6 | | 5 | 2800 |
| 26 | 200 | 1280 | | | 1280 | 130 | wo 2752 | — | 80 | 3 | 223 | 9270 | | " | | | 420 | | 385 | 6 | mw | 338 | [illegible] |
| 27 | 200 | 1284 | | | 1284 | 132 | wo 2683 | - | 75 | 3 | 223 | 9170 | | 11 | | | 426 | | 385 | 6 | | 330 | 1830 |
| 28 | 200 | 1305 | | | 1305 | 127 | wo 3178 | — | 76 | 2 | 223 | 10450 | | 11 | | | [illegible] | | 3?? | , | ✓ | 390 | 2700 |
| 29 | 200 | 1288 | | | 1288 | 133 | wo 2621 | 8270 | 80 | 3 | 223 | 8210 | | 11 | | | 420 | | 385 | 6 | [illegible] | 302 | 2700 |
| 30 | 200 | 1277 | | | 1277 | 176 | wo 2553 | ø | 75 | 3 | 222 | 7970 | | 11 | | | 426 | | 385 | 6 | D.T | 351 | 2700 |
| 31 | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | [illegible] | 110285 | | 4289 | 44574 | 4969 | 58370 | 352500 | 2305 | | | 246220 (7) | | | | | | | 11492 | | | | 83833 |
| MAXIMUM | [illegible] | 2025 | | 1306 | 2025 | 267 | 8700 | 139290 | 91 | | | 17800 | | | | | | | 385 | | | | |
| MINIMUM | [illegible] | 260 | | 200 | 1199 | 27 | 120 | 10 | 70 | | | 1390 | | | | | | | 380 | | | | |
| AVERAGE | [illegible] | 1389 | | 613 | 1496 | 177.5 | 2084.6 | 29375 | 77 | | | 8207 | | | | | | | 383 | | | | |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS *

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 1 NOV 72 3967 REPLACES DA FORM 5-98 1 JUN 58 WHICH WILL BE USED.

A.5-78

## FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CEP | BLDG. NO. 1412 | MONTH: Aug 94

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 1 w/o 1,000 LB. (2) | BOILER 2 1,000 LB. (3) | BOILER 3 1,000 LB. (4) | TOTAL 1,000 LB. (5) | WOOD 1,000 LB. (6) | NO. 2 FUEL USED LB. M.C.F. GAL. OIL (7) | N.G. PER UNIT (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. (10) | FEEDWATER HEATER TEMP. °F. (11) | MAKEUP GAL. (12) | %CO2 BOILER 1 (13) | %CO2 BOILER 2 (14) | %CO2 BOILER 3 (15) | FLUE GAS TEMPERATURE BOILER 1 °F. (16) | FLUE GAS BOILER 2 °F. (17) | FLUE GAS BOILER 3 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | #4 BLR o/s 7/0 #2 (22) | cwm/. (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 200 | | 2030 | | 2030 | 276 | 183 | 4880 | 80 | 3 | 223 | 19920 | | 11 | | | [illegible] | | 380 | 6 | PP | 28 | 430 |
| 2 | 200 | | 2033 | | 2033 | 271 | 455 | 2360 | 81 | 3 | 223 | 17770 | | 11 | | | 430 | | 380 | 6 | W | 60 | 430 |
| 3 | 200 | | 2003 | | 2003 | 257 | 487 | 4880 | 84 | 3 | 223 | 18120 | | 11 | | | 430 | | 382 | 6 | EH | 64 | 4300 |
| 4 | 200 | | 1970 | | 1970 | 264 | 473 | 4880 | 82 | 3 | 223 | 19050 | | 11 | | | 430 | | 382 | 6 | DR | 62 | 415 |
| 5 | 200 | | 2026 | | 2026 | 272 | 400 | 43070 | 80 | 3 | 223 | 13,010 | | 11 | | | 430 | | 382 | 6 | PP | 53 | 390 |
| 6 | 200 | | 2011 | | 2011 | 250 | 1115 | 39680 | 80 | 3 | 223 | 13510 | | 11 | | | 430 | | 381 | 6 | W | 147 | 420 |
| 7 | 200 | | 2022 | | 2022 | 260 | 734 | 21750 | 76 | 3 | 223 | 16090 | | 11 | | | 430 | | 381 | 6 | PP | 97 | 420 |
| 8 | 200 | | 2026 | | 2026 | 274 | 354 | 4880 | 78 | 3 | 223 | 17210 | | 11 | | | 430 | | 380 | 6 | W | 47 | 400 |
| 9 | 200 | | 2050 | | 2050 | 263 | 634 | 24120 | 78 | 3 | 223 | 16420 | | 11 | | | 430 | | 380 | 6 | PP | 79 | 410 |
| 10 | 200 | | 1977 | | 1977 | 267 | 305 | 57370 | 80 | 3 | 223 | 12430 | | 11 | | | 430 | | 380 | 6 | [illegible] | 40 | 4100 |
| 11 | 200 | | 2031 | | 2031 | 278 | 614 | 4880 | 78 | 3 | 223 | 17110 | | 11 | | | 430 | | 381 | 6 | [illegible] | 80 | 420 |
| 12 | 200 | | 1996 | | 1996 | 263 | 618 | 4880 | 80 | 3 | 223 | 14850 | | 11 | | | 430 | | 380 | 6 | W | 20 | 440 |
| 13 | 200 | | 1992 | | 1992 | 261 | 700 | 10 | 78 | 3 | 223 | 15590 | | 11 | | | 430 | | 380 | 6 | PP | 94 | 3800 |
| 14 | 200 | | 1951 | | 1951 | 259 | 528 | 22510 | 82 | 3 | 223 | 15020 | | 11 | | | 430 | | 380 | 6 | W | 72 | 370 |
| 15 | 200 | | 1970 | | 1970 | 259 | 655 | 37660 | 82 | 3 | 223 | 18590 | | 11 | | | 430 | | 380 | 6 | PP | 86 | 370 |
| 16 | 200 | | 1991 | | 1991 | 267 | 376 | 5930 | 76 | 3 | 223 | 17880 | | 11 | | | 430 | | 380 | 6 | PP | 50 | 4200 |
| 17 | 200 | 2649 | 1912 | | 1912 | 221 | 2649 | 7610 | 85 | 3 | 223 | 13990 | | 11 | | | 430 | | 380 | 6 | EH | 306 | 4,00 |
| 18 | 200 | 2700 | 1945 | | 1945 | 267 | 2700 | 4880 | 84 | 3 | 223 | 11160 | | 11 | | | 430 | | 380 | 6 | 74 | 285 | 4100 |
| 19 | 200 | 839 | 1842 | | 1842 | 235 | 1165 | 6550 | 82 | 3 | 223 | 5240 | | 11 | | | 430 | | 380 | 6 | W | 35/103 | 6900 |
| 20 | 200 | | 1986 | | 1986 | 266 | 399 | 35060 | 81 | 3 | 223 | 9080 | | 11 | | | 430 | | 386 | 6 | CCP | 51 | 3900 |
| 21 | 200 | | 1982 | | 1982 | 258 | 326 | 26110 | 80 | 3 | 223 | 10430 | | 11 | | | 430 | | 381 | 6 | W | 103 | 4400 |
| 22 | 200 | 2715 | 2043 | | 2043 | 263 | 2715 | 4880 | 83 | 3 | 223 | 9310 | | 11 | | | 430 | | 380 | 6 | DT | 333 | 400 |
| 23 | 200 | 2672 | 2038 | | 2038 | 234 | 1381 | 4880 | 78 | 3 | 223 | 6640 | | 11 | | | 430 | | 380 | 6 | " | 328 | 400 |
| 24 | 200 | 1381 | 1960 | | 1960 | 246 | 2672 | 20 | 78 | 3 | 223 | 11450 | | 11 | | | 430 | | 380 | 6 | PP | 170 | 4100 |
| 25 | 200 | | 2010 | | 2010 | 272 | 266 | 7800 | 76 | 3 | 223 | 8500 | | 11 | | | 430 | | 380 | 6 | 74 | 35 | 410 |
| 26 | 200 | | 2101 | | 2101 | 265 | 1336 | 4880 | 80 | 3 | 223 | 5730 | | 11 | | | 430 | | 380 | 6 | W | 176 | 380 |
| 27 | 200 | | 2050 | | 2058 | 273 | 550 | 2150 | 80 | 3 | 223 | 4470 | | | | | | | | | | [illegible] | 580 |
| 28 | 200 | | 2123 | | 2123 | 279 | 743 | 2820 | 80 | 3 | 223 | 11630 | | 11 | | | 430 | | 380 | 6 | DT | 98 | 400 |
| 29 | 200 | | 2160 | | 2100 | 272 | 351 | 1230 | 80 | 3 | 224 | 12460 | | 11 | | | 430 | | 381 | 6 | W | 126 | 390 |
| 30 | 200 | | 2089 | | 2089 | 279 | 750 | 770 | 80 | 3 | 224 | 8,540 | | 11 | | | 430 | | 381 | 6 | [illegible] | 69 | 630 |
| 31 | 200 | | 2109 | | 2109 | 288 | 154 | 4880 | 86 | 3 | 224 | 7310 | | 11 | | | 430 | | 384 | 6 | [illegible] | 21 | 3,200 |
| TOTAL | 6820 | 12956 | 62537 | | 62837 | 8169 | 13822 | 874295 | 2488 | | | 407100 | | | | | | | 11796 | 186 | | | |
| MAXIMUM | 220 | 2715 | 2058 | | 2058 | 288 | 2715 | 57370 | 86 | | | 19920 | | | | | | | 384 | 6 | | | |
| MINIMUM | 220 | 839 | 1842 | | 1842 | 234 | 183 | 10 | 76 | | | 5240 | | | | | | | 380 | 6 | | | |
| AVERAGE | 220 | 2159 | 2014 | | 2014 | 2653.5 | 531.6 | 28203 | 80 | | | 13132 | | | | | | | 380.5 | 6 | | | |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

404010

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 5-98, 1 JUN 58, WHICH WILL BE USED.

A.5-79

A.5-80

# FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT:

BLDG. NO.:

MONTH: Jul 94

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 1 1,000 LB. (2) | BOILER 4 1,000 LB. (3) | BOILER 3 1,000 LB. (4) | TOTAL 1,000 LB. (5) | FEED-WATER TO BOILER 1,000 LB. (6) Wood | FUEL USED LB. M.C.F. GAL. #2 Oil (7) | EVAP. LB. PER UNIT NG (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. (10) | TEMP. °F. (11) | MAKEUP GAL. (12) | %CO2 BOILER 1 (13) | 4 (14) | 3 (15) | FLUE GAS TEMPERATURE BOILER 1 °F. (16) | 4 °F. (17) | 3 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | #4 Boi F.O.S.F. (22) | Chilled water makeup (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 200 | 677 | | 1000 | 1677 | | 6000 | 614000 | 86 | 3 | 223 | 12920 | 11 | | 11 | 420 | | 420 | 380 | 13 | [illegible] | | 8200 |
| 2 | 200 | 758 | | 1000 | 1758 | | 6000 | 612600 | 86 | 3 | 223 | 15530 | 11 | | 11 | 420 | | 420 | 380 | 3 | [illegible] | | 8100 |
| 3 | 200 | 744 | | 1000 | 1744 | | 6000 | 616900 | 83.5 | 3 | 223 | 12,250 | " | | " | 420 | | 420 | 380 | 3 | [illegible] | | 8400 |
| 4 | 200 | 765 | | 1000 | 1765 | | 6,000 | 617000 | 80.5 | 3 | 223 | 12,760 | " | | " | 420 | | 420 | 380 | 3 | [illegible] | | 8400 |
| 5 | 200 | 828 | | 1000 | 1828 | | 6000 | 646,300 | 83 | 3 | 223 | 13,570 | " | | " | 420 | | 420 | 380 | 3 | [illegible] | | 8500 |
| 6 | 200 | 847 | | 1000 | 1847 | | 6000 | 657200 | 88 | 3 | 223 | 10,620 | " | | " | 430 | | 430 | 380 | 3 | [illegible] | | 8300 |
| 7 | 200 | 851 | | 1000 | 1851 | Est | 6000 | 641600 | 83 | 3 | 223 | 21,960 | " | | " | 430 | | 430 | 380 | 3 | [illegible] | | 8200 |
| 8 | 200 | 861 | | 1000 | 1861 | Est | 6000 | 665000 | 87.5 | 3 | 223 | 14,500 | " | | " | 430 | 4 | 430 | 380 | 3 | [illegible] | | 8,200 |
| 9 | 250 | 390 | 1182 | 392 | 1964 | 17P | 3048 | 276[illegible] | 87 | 3 | 223 | 18370 | | | | 430 | 430 | 430 | 380 | 3 | [illegible] | | 8500 |
| 10 | 200 | 250 | 1500 | 305 | 2095 | 203 | 2337 | 851,100 | 85 | 3 | 223 | 15,400 | | | | 430 | 430 | 430 | 380 | 3 | [illegible] | | 9600 |
| 11 | 200 | | 2058 | | 2058 | 279 | 2220 | | 88 | 3 | 223 | 17,130 | | 11 | | | 430 | | 380 | 3 | [illegible] | 29 | 8600 |
| 12 | 200 | | 1984 | | 1984 | 264 | 2507 | | 84 | 3 | 223 | 17,310 | | " | | | 430 | | 380 | 6 | [illegible] | 67 | 7100 |
| 13 | 200 | | 2103 | | 2103 | 290 | 2260 | | 87 | 3 | 223 | 25130 | | " | | | 430 | | 380 | 6 | [illegible] | 34 | 6400 |
| 14 | 200 | | 2020 | | 2020 | 278 | 419 | | 87 | 3 | 223 | 21390 | | " | | | 430 | | 380 | 6 | [illegible] | 55 | 7700 |
| 15 | 200 | | 2097 | | 2097 | 282 | 560 | | 87 | 3 | 223 | 13,200 | | " | | | 430 | | 380 | 6 | [illegible] | 49 | 7,800 |
| 16 | 200 | | 2036 | | 2036 | 266 | 872 | | 88 | 3 | 223 | 18480 | | " | | | 430 | | 380 | 6 | [illegible] | 107 | 7600 |
| 17 | 200 | | 2029 | | 2029 | 267 | 800 | | 87 | 3 | 223 | 17,870 | | " | | | 430 | | 380 | 6 | [illegible] | 92 | 7600 |
| 18 | 200 | | 2057 | | 2057 | 277 | 344 | | 84 | 3 | 223 | 18070 | | " | | | 430 | | 380 | 6 | [illegible] | 45 | 8300 |
| 19 | 200 | | 2044 | | 2044 | 273 | 440 | | 88 | 3 | 223 | 20,870 | | " | | | 430 | | 380 | 6 | [illegible] | 59 | 8400 |
| 20 | 200 | | 2067 | | 2067 | 285 | 925 | | 78 | 3 | 223 | 18490 | | " | | | 430 | | 380 | 6 | [illegible] | 122 | 8100 |
| 21 | 200 | | 2101 | | 2101 | 289 | 791 | 40 | 77 | 3 | 223 | 21440 | | " | | | 430 | | 380 | 6 | [illegible] | 104 | 6200 |
| 22 | 200 | | 2027 | | 2027 | 273 | 365 | | 78 | 3 | 223 | 17360 | | " | | | 430 | | 380 | 6 | [illegible] | 48 | 4800 |
| 23 | 200 | | 2012 | | 2012 | 260 | 949 | 895 | 84 | 3 | 223 | 17800 | | " | | | 430 | | 380 | 6 | [illegible] | 125 | 4400 |
| 24 | 200 | | 2039 | | 2039 | 257 | 1193 | 3135 | 84 | 3 | 223 | 15080 | | " | | | 430 | | 380 | 6 | CP | 159 | 4000 |
| 25 | 200 | | 1926 | | 1926 | 266 | 837 | 0 | 85 | 3 | 223 | 20240 | | " | | | 430 | | 380 | 6 | [illegible] | 111 | 4300 |
| 26 | 200 | | 2038 | | 2038 | 268 | 713 | 2410 | 84 | 3 | 223 | 18840 | | " | | | 430 | | 380 | 6 | [illegible] | 44 | 4200 |
| 27 | 200 | | 2035 | | 2038 | 264 | 682 | 2940 | 83 | 3 | 223 | 17160 | | " | | | 430 | | 380 | 6 | [illegible] | 90 | 4000 |
| 28 | 200 | | 1977 | | 1977 | 273 | 1005 | — | 79 | 3 | 223 | 19530 | | | | | 430 | | 380 | 6 | [illegible] | 133 | 4100 |
| 29 | 200 | | 1912 | | 1912 | 244 | 1062 | — | 79 | 3 | 223 | 16960 | | " | | | 430 | | 380 | 6 | [illegible] | 140 | 4000 |
| 30 | 200 | | 1989 | | 1989 | 255 | 1058 | — | 81 | 3 | 223 | 23,260 | | " | | | 430 | | 380 | 6 | [illegible] | 140 | 4100 |
| 31 | 200 | | 1998 | | 1998 | 271 | 2213 | 31760 | 78 | 3 | 223 | 11660 | | " | | | 430 | | 380 | 6 | [illegible] | 28 | 4300 |
| TOTAL | 6820 | 7051 | 45241 | 8697 | 60989 | 6052 | 75497 | 5572930 | 2601 | | | 535250 | | | | | | | | 153 | | | |
| MAXIMUM | 220 | 861 | 2103 | 1000 | 2163 | 290 | 6000 | 665000 | 88 | | | 25130 | | | | | | | | 6 | | | |
| MINIMUM | 220 | 290 | 1182 | 305 | 1677 | 171 | 344 | 40 | 77 | | | 10620 | | | | | | | | 3 | | | |
| AVERAGE | 220 | 705 | 1967 | 870 | 1967 | 253 | 2435 | 371515 | 84 | | | 17266 | | | | | | | | 5 | | | |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS: 540670

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 5-98, 1 JUN 58, WHICH WILL BE USED.

A.5-80

A.5-81

# FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CEP | BLDG. NO. 1412 | MONTH: JUNE 94

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 1 1,000 LB. (2) | BOILER 4 1,000 LB. (3) | BOILER 3 1,000 LB. (4) | TOTAL 1,000 LB. (5) | WOOD FEED WATER TO BOILER 1,000 LB. (6) | #2 FUEL USED LB. M.C.F. GAL. OIL (7) | NAT. GAS (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. (10) | TEMP. °F. (11) | MAKEUP GAL. (12) | %CO2 BOILER 1 (13) | BOILER 4 (14) | BOILER 3 (15) | FLUE GAS TEMPERATURE BOILER 1 °F. (16) | BOILER 4 °F. (17) | BOILER 3 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | #4 BLR OIL S/F (22) | CHILLED WTR MAKE-UP (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 200 | 419 | 1336 | 190 | 1845 | 123 | 28 | 448100 | 83° | 3 | 223 | 7548 | | 6 | | 420 | 420 | 420 | 385 | 6 | DN | 7 | 18900 |
| 2 | 200 | | 1421 | 588 | 2009 | 122 | 60 | 383600 | 85° | 3 | 223 | 13240 | | | | | | | 386 | 6 | ELB | | 18400 |
| 3 | 200 | | 1390 | 636 | 2026 | 122 | 52 | 432020 | 77 | 3 | 223 | 10790 | | | | | | | 383 | 6 | W | 7 | 20600 |
| 4 | 200 | 5 1 | 1366 | 857 | 2223 | 123 | 44 | 456390 | 81 | 3 | 223 | 10470 | | | | | | | 385 | 6 | EZ | 6 | 18100 |
| 5 | 200 | 50 | | 1777 | 1827 | 123 | 50 | 654220 | 80 | 3 | 223 | 8960 | | | | | | | 385 | 6 | EZ | 0 | 10,800 |
| 6 | 200 | 900 | | 948 | 1848 | — | 7100 | 652000 | 82 | 3 | 223 | 9080 | | | | | | | 382 | 3 | W | — | 11010 |
| 7 | 200 | 997 | | 1000 | 1997 | — | 7400 | 565400 | 81 | 3 | 223 | 11300 | | | | | | | 383 | 3 | EZ | — | 9490 |
| 8 | 200 | 878 | | 891 | 1766 | — | 7350 | 655410 | 87 | 3 | 223 | 9000 | | | | | | | 382 | 3 | FW | — | 1800 |
| 9 | 200 | 741 | | 1112 | 1853 | — | 7350 | 663660 | 86° | 3 | 223 | 4580 | | | | | | | 382 | 3 | ELB | — | 6600 |
| 10 | 200 | 861 | | 1000 | 1861 | — | 7400 | 652000 | 82 | 3 | 223 | 8600 | | | | | | | 382 | #3-3 | DN | — | 3500 |
| 11 | 200 | 830 | | 1000 | 1830 | -0- | 7400 | 640000 | 81 | 3 | 223 | 9520 | | | | | | | 383 | #3-3 | EE | — | 3400 |
| 12 | 2000 | 824 | | 1000 | 1824 | — | 7375 | 650000 | 80 | 3 | 223 | 11,130 | | | | | | | 382 | #3-3 | DN | — | 3500 |
| 13 | 200 | 832 | | 1000 | 1832 | — | 7375 | 650000 | 81 | 3 | 223 | 12,140 | | | | | | | 383 | #3-3 | EZ | — | 3500 |
| 14 | 200 | 829 | | 1000 | 1829 | — | 7329 | 650,000 | 84 | 3 | 223 | 9190 | | | | | | | 383 | #3-3 | DN | — | 2530 |
| 15 | 200 | 879 | | 1000 | 1879 | — | 7400 | 650,000 | 86 | 3 | 223 | 12370 | | | | | | | 383 | #3-3 | FW | — | 3800 |
| 16 | 200 | 901 | | 1000 | 1901 | — | 7400 | 650,000 | 80 | 3 | 223 | 11090 | | | | | | | 383 | #3-3 | FW | — | 1300 |
| 17 | 200 | 882 | | 1000 | 1882 | — | 7375 | 650000 | 78 | 3 | 223 | 14452 | | | | | | | 382 | #3-3 | EZ | — | 4100 |
| 18 | 200 | 863 | | 1000 | 1863 | — | 7375 | 650000 | 77 | 3 | 223 | 11850 | | | | | | | 383 | #3-3 | DN | — | 4500 |
| 19 | 200 | 850 | | 1000 | 1850 | — | 7400 | 650000 | 75 | 3 | 223 | 11,050 | | | | | | | 383 | #3-3 | DN | — | 4400 |
| 20 | 200 | 894 | | 1000 | 1894 | — Est | 7350 | 650000 | 84 | 3 | 223 | 14080 | | | | | | | 383 | #3-3 | DN | | 4800 |
| 21 | 200 | 914 | | 1000 | 1914 | " | 7375 | 659000 | 91 | 3 | 223 | 14310 | | | | | | | 382 | #3-3 | DN | | 4700 |
| 22 | 200 | 865 | | 1000 | 1865 | | 7350 | 655100 | 91 | 3 | 223 | 12920 | | | | | | | 383 | #3-3 | EE | | 4300 |
| 23 | 200 | 884 | | 1000 | 1884 | | 7400 | 677200 | 90 | 3 | 223 | 9720 | | | | | | | 384 | #3-3 | EE | | 4,300 |
| 24 | 200 | 863 | | 1000 | 1863 | | 7325 | 627,000 | 85 | 3 | 223 | 15520 | | | | | | | 383 | #3-3 | DN | | 4500 |
| 25 | 200 | 771 | | 1000 | 1771 | | 7400 | 614,600 | 80 | 3 | 223 | 14,020 | | | | | | | 383 | #3-3 | DP | — | 7300 |
| 26 | 200 | 764 | | 1000 | 1764 | | 7400 | 627,900 | 81 | 3 | 223 | 15,320 | | | | | | | 383 | #3-3 | DP | — | 8,000 |
| 27 | 200 | 846 | | 1000 | 1846 | | 7375 | 624,340 | 88 | 3 | 223 | 14,220 | | | | | | | 383 | #3-3 | DP | — | 7,600 |
| 28 | 200 | 745 | | 1000 | 1745 | | 7375 | 624,540 | 89 | 3 | 223 | 14,180 | | | | | | | 383 | #3-3 | DP | — | 7,800 |
| 29 | 200 | 770 | | 1000 | 1770 | | 7375 | 615,000 | 85 | 3 | 223 | 12,200 | | | | | | | 383 | #3-3 | FW | — | 8,100 |
| 30 | 200 | 884 | | 1002 | 1884 | Est | 7400 | 532,000 | 83 | 3 | 223 | 15,310 | | | | | | | 383 | #3-3 | EZ | | 8300 |
| 31 | 200 | [illegible] | | [illegible] | [illegible] | | [illegible] | [illegible] | | | | | | | | | | | | | | | |
| TOTAL | 6600 | 21733 | 5513 | 28999 | 56245 | 613 | 184388 | 18922740 | 2497 | | | 352488 | | | | | | | 11493 | 105 | | | 215,330 |
| MAXIMUM | [illegible] | 997 | 1421 | 1112 | 2223 | 123 | 7404 | 677200 | 91 | | | 17420 | | | | | | | 386 | 6 | | | |
| MINIMUM | [illegible] | 50 | 1336 | 190 | 1745 | 122 | 44 | 383600 | 75 | | | 4580 | | | | | | | 382 | 3 | | | |
| AVERAGE | [illegible] | 834 | 1378 | 967 | 1875 | 122.6 | 6146 | 630758 | 83 | | | 11750 | | | | | | | 383 | 3.5 | | | |

Jun 94

Natural Gas 18,922,740 Cu. Ft.

Wood 613 Tons

Used Oil -0-

#2 Oil 184,388 gals

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS 352588

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3967, 1 NOV 72 REPLACES DA FORM 598, 1 JUN 58, WHICH WILL BE USED.

A.5-81

**FACILITIES ENGINEERING OPERATING LOG** *(Boiler Plant)*

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: C2P | BLDG. NO. 1412 | MONTH: MAY '94

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 1 1,000 LB. (2) | BOILER 2 1,000 LB. (3) | BOILER 3 1,000 LB. (4) | TOTAL 1,000 LB. (5) | WOOD FEED-WATER TO BOILER 1,000 LB. (6) | No. 2 FUEL USED LB. M.C.F. GAL. OIL (7) | Nat Gas (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. (10) | FEEDWATER HEATER TEMP. °F. (11) | MAKEUP GAL. (12) | %CO2 BOILER 1 (13) | %CO2 BOILER 2 (14) | %CO2 BOILER 3 (15) | FLUE GAS TEMPERATURE BOILER 1 °F. (16) | BOILER 2 °F. (17) | BOILER 3 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | No. 4 BLR OIL S/F (22) | Chilled Water Make-up (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 200 | 267 | 1682 | | 1942 | 232 | 0 | 202530 | 82.5 | 3 | 223 | 9870 | | 6 | | | 420 | | 384 | | EB | | |
| 2 | 200 | 356 | 834 | 600 | 1790 | 115 | 15 | 579140 | 78 | 3 | 223 | 14070 | | 6 | | 420 | 420 | 420 | 385 | | Dn | 2 | |
| 3 | 200 | 317 | 962 | 600 | 1879 | 129 | 208 | 597390 | 67 | 3 | 223 | 7580 | | 6 | | 420 | 420 | 420 | 385 | | Dn | 27 | |
| 4 | 200 | | 1681 | | 1681 | 225 | 356 | 6770 | 67 | 3 | 223 | 7980 | | 6 | | | 420 | | 385 | | FW | 45 | |
| 5 | 200 | | 1766 | | 1766 | 174 | 144 | 2390 | 67 | 3 | 223 | 11910 | | 7 | | | 450 | | 387 | | W | 5 | |
| 6 | 200 | | 1260 | | 1260 | 173 | 169 | 4160 | 72 | 3 | 223 | 7940 | | 6 | | | 450 | | 385 | | Dn | 9 | |
| 7 | 200 | | 1293 | | 1293 | 176 | 165 | 10600 | 77 | 3 | 223 | 12030 | | 6 | | | 450 | | 386 | | EB | 14 | |
| 8 | 200 | 290 | 1375 | | 1665 | 189 | 165 | 241680 | 75 | 3 | 223 | 9730 | | 6 | | 420 | 420 | | 385 | | EB | 9 | |
| 9 | 200 | 691 | 1233 | | 1924 | 170 | — | 536920 | 75 | 3 | 223 | 8760 | | 6 | | 420 | 420 | | 385 | | Dn | 0 | |
| 10 | 200 | 579 | 1357 | | 1936 | 187 | 254 | 418320 | 73 | 3 | 223 | 9730 | | 6 | | 420 | 420 | | 385 | | Dn | 34 | |
| 11 | 200 | 758 | 1154 | | 1912 | 156 | 176 | 548930 | 72 | 3 | 223 | 11,390 | | 6 | | 420 | 420 | | 385 | | FW | 10 | |
| 12 | 220 | 801 | 1175 | | 1976 | 162 | 104 | 616220 | 78 | 3 | 223 | 8350 | | 6 | | 420 | 421 | | 383 | | W | 13 | |
| 13 | 220 | 773 | 1246 | | 2019 | 167 | 247 | 532770 | 73 | 3 | 223 | 5510 | | 6 | | 420 | 420 | | 385 | | TY | 33 | |
| 14 | 220 | 700 | 1223 | | 1923 | 167 | 162 | 501600 | 74 | 3 | 223 | 11480 | | 6 | | 420 | 420 | | 385 | | TY | 8 | |
| 15 | 220 | 672 | 1277 | | 1949 | 175 | 147 | 512000 | 72 | 3 | 223 | 8280 | | 6 | | 420 | 420 | | 385 | | TY | 6 | |
| 16 | 220 | 639 | 1273 | | 1912 | 175 | 242 | 504110 | 83° | 3 | 223 | 5680 | — | 6 | | 420 | 420 | | 385 | | Dn | 32 | |
| 17 | 220 | 669 | 1292 | | 1961 | 167 | 181 | 492180 | 76 | 3 | 223 | 10250 | | 6 | | 420 | 420 | | 383 | | W | 11 | 25,300 |
| 18 | 220 | 649 | 1285 | | 1934 | 174 | 149 | 463150 | 71 | 3 | 223 | 7530 | | 6 | | 420 | 420 | | 385 | | Dn | 20 | 17,800 |
| 19 | 220 | 416 | 1369 | | 1785 | 186 | 118 | 316890 | 59 | 3 | 223 | 9460 | | 6 | | 420 | 420 | | 382 | | W | 16 | 16,300 |
| 20 | 220 | — | 1602 | | 1602 | 221 | 270 | 5900 | 60 | 3 | 223 | 11870 | | 6 | | — | 420 | | 382 | | DR | 36 | 12000 |
| 21 | 220 | — | 1663 | | 1663 | 228 | 163 | 6320 | 60 | 3 | 223 | 12320 | | 6 | | — | 420 | | 383 | | EB | 8 | 13810 |
| 22 | 220 | 100 | 1021 | 273 | 1394 | 130 | 590 | 258290 | 67 | 3 | 223 | 11510 | | 6 | | 420 | 422 | 420 | 383 | | Dn | 78 | 13600 |
| 23 | 220 | 400 | 374 | 798 | 1572 | 47 | 226 | 737900 | 73 | 3 | 223 | 8470 | | 6 | | 420 | 420 | 420 | 383 | | Dn | 30 | 15200 |
| 24 | 220 | 640 | 1395 | | 2035 | 192 | 154 | 403100 | 84 | 3 | 223 | 12550 | | 6 | | — | 420 | — | 384 | | EB | 7 | 18500 |
| 25 | 220 | 649 | 1370 | | 2019 | 189 | 0 | 505100 | 80 | 3 | 223 | 9700 | | 6 | | 420 | 420 | | 384 | | TY | 0 | 21,600 |
| 26 | 220 | 594 | 1361 | | 1955 | 186 | 73 | 456740 | 83 | 3 | 223 | 10950 | | 6 | | 420 | 420 | | 384 | | [illegible] | 9 | 23,200 |
| 27 | 220 | 591 | 1338 | | 1929 | 184 | 126 | 484710 | 82 | 3 | 223 | 10170 | | 6 | | 420 | 420 | | 384 | | EB | 3 | 17600 |
| 28 | 220 | 629 | 1254 | | 1883 | 173 | 0 | 469600 | 71 | 3 | 223 | 7960 | | 6 | | 420 | 420 | | 384 | | EF | 0 | 14900 |
| 29 | 220 | 628 | 1272 | | 1900 | 175 | 87 | 506500 | 73 | 3 | 223 | 9910 | | 6 | | 420 | 420 | | 384 | | TY | 11 | 20400 |
| 30 | 220 | 714 | 1264 | | 1978 | 173 | 57 | 468790 | 68 | 3 | 223 | 8850 | | 6 | | 420 | 420 | | 384 | | EJ | 7 | 19000 |
| 31 | 220 | 660 | 1282 | | 1942 | 177 | 165 | 460030 | 79 | 3 | 223 | 11950 | | 6 | | 420 | 420 | | 382 | | W | 22 | 18200 |
| TOTAL | 6820 | 14182 | 39933 | 2271 | 56386 | 5374 | 4853 | 11816530 | 2271 | | | 305540 | | | | | | | 11911 | 186 | | | |
| MAXIMUM | 220 | 801 | 1766 | 798 | 2035 | 228 | 590 | 616220 | 84 | | | 14070 | | | | | | | 384 | 6 | | | |
| MINIMUM | 220 | 100 | 374 | 273 | 1260 | 47 | 15 | 2390 | 59 | | | 5518 | | | | | | | 382 | 6 | | | |
| AVERAGE | 220 | 567 | 1288 | 568 | 1819 | 173 | 180 | 381178 | 73 | | | 9856 | | | | | | | 384 | 6 | | | |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)
Wood; 1934.64, OiL; 26.92, Nat. Gas; 487.31

REMARKS
309740

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 5-98, 1 JUN 58, WHICH WILL BE USED.

A.5-82

## FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313 — GAS

PLANT: CER | BLDG. NO. 1412 | MONTH: APRIL 94

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 4 1,000 LB. (2) | BOILER 1 1,000 LB. (3) | BOILER 3 1,000 LB. (4) | TOTAL 1,000 LB. (5) | HARD WATER TO BOILER 1,000 LB. (6) | NO 2 FUEL USED LB. M.C.F. GAL. OIL (7) | GAS (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. (10) | TEMP. °F. (11) | MAKEUP GAL. (12) | % CO2 BOILER 4 (13) | 2 (14) | 3 (15) | FLUE GAS TEMPERATURE BOILER 4 °F. (16) | 2 °F. (17) | 3 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | No 4 AIR OIL S/F (22) | (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 220 | 1237 | | | 1237 | 170 | -0- | -0- | 56 | 3 | 223 | 22740 | 7 | | | 420 | | | 376 | 6 | EZ | -0- | |
| 2 | 220 | 1206 | | | 1206 | 166 | 0 | 0 | 60 | 3 | 223 | 27130 | 7 | | | 420 | | | 377 | 6 | W | -0- | |
| 3 | 220 | 1178 | | | 1178 | 162 | 0 | 0 | 65 | 3 | 223 | 22670 | 7 | | | 420 | | | 375 | 6 | EZ | -0- | |
| 4 | 220 | 1213 | | | 1213 | 167 | 11 | 0 | 66 | 3 | 223 | 22190 | 7 | | | 470 | | | 377 | 6 | W | 2 | |
| 5 | 220 | 1231 | | | 1231 | 170 | -0- | -0- | 69 | 3 | 223 | 23930 | 7 | | | 470 | | | 377 | 6 | EZ | -0- | |
| 6 | 220 | 1199 | | | 1199 | 165 | 27 | -0- | 75 | 3 | 223 | 24730 | 7 | | | 470 | | | 377 | 6 | EZ | 4 | |
| 7 | 220 | 1238 | | | 1238 | 120 | 24 | 600 | 63 | 3 | 223 | 24140 | 7 | | | 470 | | | 376 | 6 | MW | 3 | |
| 8 | 220 | 1224 | | | 1224 | 169 | 0 | 0 | 59 | 3 | 223 | 20050 | 7 | | | 470 | | | 377 | 6 | W | 0 | |
| 9 | 220 | 1121 | | | 1121 | 254 | -0- | -0- | 64 | 3 | 223 | 22500 | 7 | | | 470 | | | 376 | 6 | EZ | -0- | |
| 10 | 220 | 1138 | | | 1138 | 157 | 30 | | 71 | 3 | 223 | 21360 | 7 | | | 460 | | | 378 | 6 | W | 4 | |
| 11 | 220 | 1397 | | | 1397 | 186 | 381 | - | 71 | 3 | 223 | 25540 | 7 | | | 460 | | | 377 | 6 | EZ | 50 | |
| 12 | 220 | 1807 | | | 1807 | 249 | 132 | - | 73 | 3 | 223 | 16220 | 7 | | | 460 | | | 378 | 6 | W | 17 | |
| 13 | 200 | 1771 | | | 1771 | 244 | 323 | -0- | 71 | 3 | 223 | 24130 | 7 | | | 460 | | | 376 | 6 | EZ | 51 | |
| 14 | 200 | 1508 | | | 1508 | 202 | 298 | -0- | 76 | 3 | 223 | 20810 | 7 | | | 460 | | | 375 | 6 | [illegible] | 39 | |
| 15 | 200 | 1281 | | | 1281 | 274 | 122 | - | 75 | 3 | 223 | 4740 | 7 | | | 460 | | | 375 | 6 | [illegible] | 16 | |
| 16 | 200 | 1311 | | | 1311 | 280 | 3 | - | 68 | 3 | 223 | 4500 | 7 | | | 460 | | | 378 | 6 | EZ | — | |
| 17 | 200 | 1340 | | | 1340 | 284 | 5 | - | 65 | 3 | 223 | 18250 | 7 | | | 460 | | | 376 | 6 | [illegible] | 0.65 | |
| 18 | 200 | 1340 | | | 1340 | 284 | 5 | | 70 | 3 | 223 | 18280 | 7 | | | 460 | | | 376 | 6 | [illegible] | [illegible] | |
| 19 | 200 | 1330 | | | 1330 | 281 | 49 | | 70 | | | 13500 | | | | | | | 37[illegible] | | | 15 | |
| 20 | 200 | 1713 | | | 1713 | 234 | 97 | | 76 | 3 | 223 | 10890 | 7 | | | 460 | | | 375 | | | 13 | |
| 21 | 200 | 2034 | | | 2034 | 268 | 645 | | 78 | 3 | 223 | [illegible] | 7 | | | 460 | | | 378 | 6 | | 86 | |
| 22 | 200 | 2012 | | | 2012 | 277 | 152 | | 75 | 3 | 223 | 3840 | 7 | | | 460 | | | 376 | 6 | | 20 | |
| 23 | 200 | 1399 | | | 1399 | 267 | 55 | | 61 | 3 | 223 | 4600 | 7 | | | 460 | | | 377 | 6 | | 7 | |
| 24 | 200 | 1433 | | | 1433 | 196 | 92 | | 67 | 3 | 223 | 10260 | 7 | | | 460 | | | 378 | 6 | | 12 | |
| 25 | 200 | 1837 | | | 1837 | 242 | 586 | | 74 | 3 | 223 | 9830 | 7 | | | 460 | | | 379 | 6 | [illegible] | 72 | |
| 26 | 200 | 2019 | | | 2019 | 278 | 191 | | 75 | 3 | 223 | 10130 | 7 | | | 460 | | | 378 | 6 | Bn | 25 | |
| 27 | 200 | 1932 | | | 1932 | 262 | 219 | 68910 | 74 | 3 | 223 | 18010 | 7 | | | 460 | | | 379 | 6 | W | 29 | |
| 28 | 200 | 1540 | 170 | 250 | 1960 | 296 | 890 | 366800 | 74 | 3 | 223 | 7180 | 7 | | | 460 | | 420 | 378 | 6 | Bn | [illegible] | |
| 29 | 200 | 1170 | 769 | | 1939 | 261 | 01 | 191400 | 71 | 3 | 223 | 13110 | 7 | | | 460 | | | 378 | 6 | Bn | 0 | |
| 30 | 200 | 1130 | 880 | | 2010 | 256 | 18 | 551500 | 75 | 3 | 223 | 14520 | 7 | | | 460 | | | 379 | 6 | Bn | | |
| 31 | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | 6600 | 42289 | 1819 | 250 | 44358 | 6871 | 4412 | 1710010 | 2087 | | | 453418 | | | | | | | 11316 | 180 | | | |
| MAXIMUM | 220 | 2034 | 880 | 250 | 2034 | 296 | 890 | 604310 | 78 | | | 27130 | | | | | | | 379 | 6 | | | |
| MINIMUM | 220 | 1130 | 170 | 250 | 1121 | 157 | 5 | 191900 | 56 | | | 3840 | | | | | | | 375 | 6 | | | |
| AVERAGE | 220 | 1410 | 606 | 250 | 1479 | 229 | 192 | 428503 | 69.6 | | | 15114 | | | | | | | 377 | 6 | | | |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 5-98, 1 JUN 58, WHICH WILL BE USED.

A.5-83

# FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART FORT STEWART, GEORGIA 31313

PLANT: CEP

BLDG. NO.: 1412

MONTH: MAR 94

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 4 1,000 LB. (2) | BOILER 2 1,000 LB. (3) | BOILER 3 1,000 LB. (4) | TOTAL 1,000 LB. (5) | WOOD 1,000 LB. (6) | NO. 2 FUEL USED GAL. OIL (7) | WASTE OIL (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. (10) | FEEDWATER HEATER TEMP. °F. (11) | MAKEUP GAL. (12) | %CO2 BOILER 4 (13) | %CO2 BOILER 2 (14) | %CO2 BOILER 3 (15) | FLUE GAS TEMPERATURE BOILER 4 °F. (16) | BOILER 2 °F. (17) | BOILER 3 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | NO. 4 BLR OIL S.F. (22) | (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 220 | 1587 | | | 1587 | 217 | 87 | | 58 | 3 | 223 | 25100 | 7 | | | 450 | | | 375 | 6 | W | 11 | |
| 2 | 220 | 1463 | | | 1463 | 195 | 346 | | 62 | 3 | 223 | 20320 | 7 | | | 450 | | | 375 | 6 | DL | 45 | |
| 3 | 220 | 1710 | | | 1710 | 217 | 978 | | 52 | 3 | 223 | 23750 | 7 | | | 450 | | | 375 | 6 | DL | 129 | |
| 4 | 220 | 1555 | | | 1555 | 206 | 402 | | 61 | 3 | 223 | 22910 | 7 | | | 450 | | | 375 | 6 | WR | 53 | |
| 5 | 220 | 1422 | | | 1422 | 188 | 427 | | 63 | 3 | 223 | 17320 | 7 | | | 450 | | | 374 | 6 | W | 56 | |
| 6 | 220 | 1400 | | | 1400 | 187 | 307 | | 63° | 3 | 225 | 25590 | 7 | | | 450 | | | 375 | 6 | Br | 40 | |
| 7 | 220 | 1387 | | | 1387 | 188 | 149 | | 67 | 3 | 223 | 23860 | 7 | | | 450 | | | 378 | 6 | W | 20 | |
| 8 | 220 | 1415 | | | 1415 | 192 | 140 | | 68° | 3 | 223 | 22170 | 7 | | | 450 | | | 377 | 6 | Br | 18 | |
| 9 | 220 | 1387 | | | 1387 | 191 | 186 | | 68° | 3 | 223 | 20290 | 7 | | | 450 | | | 378 | 6 | Br | 26 | |
| 10 | 220 | 1372 | | | 1372 | 186 | 160 | | 66° | 3 | 223 | 26490 | 7 | | | 450 | | | 376 | 6 | Br | 21 | |
| 11 | 220 | 1670 | | | 1670 | 227 | 146 | | 45 | 3 | 223 | 28540 | 7 | | | 450 | | | 373 | 6 | W | 19 | |
| 12 | 220 | 1596 | | | 1596 | 211 | 496 | | 51 | 3 | 223 | 23920 | 7 | | | 450 | | | 373 | 6 | Br | 63 | |
| 13 | 220 | 1525 | | | 1525 | 204 | 338 | | 52 | 3 | 227 | 23450 | 7 | | | 450 | | | 376 | 6 | W | 45 | |
| 14 | 220 | 1463 | | | 1463 | 199 | 122 | | 58 | 3 | 223 | 27460 | 7 | | | 458 | | | 375 | 6 | Br | 16 | |
| 15 | 220 | 1331 | | | 1331 | 182 | 67 | | 58 | 3 | 223 | 25260 | 7 | | | 450 | | | 378 | 6 | W | 9 | |
| 16 | 220 | 1408 | | | 1408 | 194 | 97 | | 63 | 3 | 223 | 26090 | 7 | | | 450 | | | 376 | 6 | Br | 13 | |
| 17 | 220 | 1501 | | | 1501 | 206 | 37 | | 54 | 3 | 223 | 26040 | 7 | | | 450 | | | 377 | 6 | Br | 5 | |
| 18 | 220 | 1422 | | | 1422 | 193 | 19 | | 64° | 3 | 223 | 23560 | 7 | | | 450 | | | 376 | 6 | Br | 3 | |
| 19 | 220 | 1433 | | | 1433 | 195 | 151 | | 64 | 3 | 223 | 24340 | 7 | | | 420 | | | 373 | 6 | [illegible] | 19 | |
| 20 | 220 | 1326 | | | 1326 | 183 | -0- | | 67 | 3 | 223 | 29390 | 7 | | | 420 | | | 374 | 6 | EJ | 0 | |
| 21 | 220 | 1292 | | | 1292 | 178 | 27 | | 71 | 3 | 223 | 28510 | 7 | | | 420 | | | 376 | 6 | W | 4 | |
| 22 | 220 | 1307 | | | 1307 | 180 | -0- | | 67 | 3 | 223 | 26570 | 7 | | | 420 | | | 373 | 6 | EJ | -0- | |
| 23 | 220 | 1280 | | | 1280 | 176 | -0- | | 65 | 3 | 223 | 28150 | 7 | | | 420 | | | 375 | 6 | MW | -0- | |
| 24 | 220 | 1261 | | | 1261 | 174 | -0- | | 73 | 3 | 223 | 27000 | 7 | | | 420 | | | 374 | 6 | EJ | -0- | |
| 25 | 220 | 1240 | | | 1240 | 179 | 0 | | 70 | 3 | 223 | 31750 | 7 | | | 420 | | | 375 | 6 | DL | 0 | |
| 26 | 220 | 1260 | | | 1260 | 173 | 3 | | 63 | 3 | 223 | 24160 | 7 | | | 420 | | | 375 | 6 | EJ | -0- | |
| 27 | 220 | 1257 | | | 1257 | 173 | 88 | | 68 | 3 | 223 | 27560 | 7 | | | 420 | | | 378 | 6 | W | 12 | |
| 28 | 220 | 1190 | | | 1190 | 164 | -0- | | 72 | 3 | 223 | 31250 | 7 | | | 420 | | | 376 | 6 | EE | -0- | |
| 29 | 220 | 1329 | | | 1329 | 183 | 85 | | 62 | 3 | 223 | 31690 | 7 | | | 420 | | | 373 | 6 | W | 11 | |
| 30 | 220 | 1306 | | | 1306 | 180 | 48 | | 56 | 3 | 223 | 28445 | 7 | | | 420 | | | 375 | 6 | EJ | 6 | |
| 31 | 220 | 1306 | | | 1306 | 180 | 0 | | 57 | 3 | 223 | 23000 | 7 | | | 420 | | | 377 | 6 | W | 0 | |
| TOTAL | 6820 | 43390 | | | 43390 | 5894 | 5736 | | 1926 | 93.0 | 6820 | 793880 | 229.4 | | | 13082 | | | 11646 | 186 | | | |
| MAXIMUM | 220 | 1710 | | | 1710 | 227 | 978 | | 73 | 3.0 | 220 | 31750 | 7.4 | | | 422 | | | 378 | 6 | | | |
| MINIMUM | 220 | 1240 | | | 1240 | 164 | 31 | | 45 | 3.0 | 220 | 17320 | 7.4 | | | 422 | | | 373 | 6 | | | |
| AVERAGE | 220 | 1400 | | | 1400 | 190 | 239 | | 62 | 3.0 | 220 | 25610 | 7.4 | | | 422 | | | 376 | 6 | | | |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

8

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 1 NOV 72 3967 REPLACES DA FORM 5-98, 1 JUN 58, WHICH WILL BE USED.

A.5-84

**FACILITIES ENGINEERING OPERATING LOG** *(Boiler Plant)*

For use of this form, see AR 420-49; the proponent agency is USACE.

| INSTALLATION | PLANT | BLDG. NO. | MONTH |
|---|---|---|---|
| HEADQUARTERS FORT STEWART<br>FORT STEWART, GEORGIA 31313 | CEP | 1412 | Feb 94 |

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 1 1,000 LB. (2) | BOILER 2 1,000 LB. (3) | BOILER #4 1,000 LB. (4) | TOTAL 1,000 LB. (5) | WOOD 1,000 LB. (6) | NO. 2 OIL FUEL USED GAL. (7) | Waste OIL PER UNIT (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. (10) | TEMP. °F. (11) | MAKEUP GAL. (12) | %CO2 BOILER 1 (13) | 2 (14) | #4 (15) | FLUE GAS TEMPERATURE BOILER 1 °F. (16) | 2 °F. (17) | #4 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | #4 BLR S/F For oil used (22) | (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 200 | | | 1931 | 1931 | 254 | 638 | — | 43 | | | 14200 | | | 7.4 | | | 420 | 373 | 6 | W | 84 | |
| 2 | 200 | | | 2089 | 2089 | 217 | 1108 | — | 38 | | | 17160 | | | 7 | | | 420 | 375 | 6 | Dn | 146 | |
| 3 | 200 | | | 2027 | 2027 | 274 | 258 | — | 40 | | | 17440 | | | 7 | | | 420 | 325 | 6 | JL | 34 | |
| 4 | 200 | | | 2012 | 2012 | 259 | 1025 | — | 43 | | | 15090 | | | 7 | | | 420 | 375 | 6 | Dn | 135 | |
| 5 | 200 | | | 1851 | 1851 | 239 | 831 | — | 45 | | | 15960 | | | 7 | | | 420 | 373 | 6 | W | 110 | |
| 6 | 200 | | | 1778 | 1778 | 229 | 740 | — | 55 | | | 20770 | | | 7 | | | 420 | 375 | 6 | Dn | 95 | |
| 7 | 200 | | | 1687 | 1687 | 228 | 239 | | 59 | | | 15340 | | | 7 | | | 420 | 377 | 6 | W | 31 | |
| 8 | 200 | | | 1594 | 1594 | 210 | 528 | | 63 | | | 17870 | | | 7 | | | 420 | 375 | 6 | Dn | 70 | |
| 9 | 200 | | | 1515 | 1515 | 199 | 489 | w/o | 69 | | | 19420 | | | 7 | | | 420 | 375 | 6 | JL | 65 | |
| 10 | 200 | | | 1516 | 1516 | 206 | 156 | | 65 | | | 18420 | | | 7 | | | 420 | 374 | 6 | JL | 20 | |
| 11 | 200 | | | 1501 | 1501 | 203 | 189 | | 66 | | | 20090 | | | 7 | | | 420 | 376 | 6 | W | 25 | |
| 12 | 200 | | | 1505 | 1505 | 203 | 200 | | 52 | | | 19010 | | | 7 | | | 420 | 375 | 6 | Dn | 26 | |
| 13 | 200 | | | 1652 | 1652 | 222 | 291 | | 55 | | | 18160 | | | 7 | | | 420 | 373 | 6 | W | 38 | |
| 14 | 200 | | | 1810 | 1810 | 238 | 582 | | 52 | | | 21660 | | | 7 | | | 420 | 374 | 6 | Dn | 76 | |
| 15 | 200 | | | 1792 | 1792 | 240 | 409 | | 56 | | | 20380 | | | 7 | | | 420 | 375 | 6 | W | 119 | |
| 16 | 200 | | | 1757 | 1757 | 238 | 171 | | 52 | | | 23820 | | | 7 | | | 420 | 375 | 6 | Dn | 22 | |
| 17 | 200 | | | 1623 | 1623 | 220 | 209 | | 55 | | | 20440 | | | 7 | | | 420 | 324 | 6 | JL | 28 | |
| 18 | 200 | | | 1598 | 1598 | 215 | 294 | | 57 | | | 16770 | | | 7 | | | 420 | 375 | 6 | Dn | 39 | |
| 19 | 200 | | | 1466 | 1466 | 195 | 367 | | 61 | | | 20080 | | | 7 | | | 420 | 377 | 6 | W | 48 | |
| 20 | 200 | | | 1511 | 1511 | 202 | 356 | | 60 | | | 25150 | | | 7 | | | 420 | 376 | 6 | Dn | 45 | |
| 21 | 200 | | | 1481 | 1481 | 204 | 13 | | 65 | | | 21440 | | | 7 | | | 420 | 378 | 6 | W | 2 | |
| 22 | 200 | | | 1389 | 1389 | 190 | 53 | | 65 | | | 21490 | | | 7 | | | 420 | 377 | 6 | Dn | 7 | |
| 23 | 200 | | | 1395 | 1395 | 190 | 73 | | 66 | | | 26080 | | | 7 | | | 420 | 376 | 6 | JL | 10 | |
| 24 | 200 | | | 1446 | 1446 | 184 | 25 | 890 | 60 | | | 22740 | | | 7 | | | 420 | 328 | 6 | JL | 211 | |
| 25 | 200 | | | 1540 | 1540 | 168 | — | 2509 | 50 | | | 21170 | | | 7 | | | 420 | 375 | 6 | W | 320 | |
| 26 | 200 | | | 1556 | 1556 | 168 | — | 2462 | 55 | | | 21720 | | | 7 | | | 420 | 375 | 6 | RS | 202 | |
| 27 | 200 | | | 1811 | 1811 | 241 | 472 | — | 44 | | | 19210 | | | 7 | | | 420 | 373 | 6 | W | 62 | |
| 28 | 200 | | | 1641 | 1641 | 216 | 564 | — | 48 | | | 20120 | | | 7 | | | 420 | 375 | 6 | Dn | 74 | |
| 29 | | | | | | | | | | | | | | | | | | | | | | | |
| 30 | | | | | | N.G. | (2548) | | | | | | | | | | | | | | | | |
| 31 | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | 616A | | | 46474 | 46474 | 5846 | 13678 | 5861 | 1539 | | | 551230 | | | 207.2 | | | 11816 | | 168 | | | |
| MAXIMUM | 200 | | | 2089 | 2089 | 274 | | | 69 | | | 26080 | | | 7.4 | | | 422 | | 6 | | | |
| MINIMUM | 200 | | | 1389 | 1389 | 103 | | | 38 | | | 14200 | | | 7.4 | | | 422 | | 6 | | | |
| AVERAGE | 220 | | | 1660 | 1660 | 209 | | | 55 | | | 19687 | | | 7.4 | | | 422 | | 6 | | | |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS) 19539

2509
13
698

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 1 NOV 72 3967 REPLACES DA FORM 5-98 1 JUN 58 WHICH WILL BE USED.

A.5-85

# FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: C.E.P. | BLDG. NO.: 1417 | MONTH: JAN 94

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 1 1,000 LB. (2) | BOILER 2 1,000 LB. (3) | BOILER 4 1,000 LB. (4) | TOTAL 1,000 LB. (5) | BOILER WHB 1,000 LB. (6) | FUEL USED C.F. NG (7) | EVAP. LB. PER UNIT (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. WO (10) | TEMP. °F. (11) | MAKEUP GAL. (12) | %CO2 BOILER 1 (13) | BOILER 3 (14) | BOILER 4 (15) | FLUE GAS TEMPERATURE BOILER 1 °F. (16) | BOILER 3 °F. (17) | BOILER 4 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES #4 (20) | PREVENT MAINT. CHECK OPR (21) | No. 4 BLR No 2 FO (22) | S.F. Oil #4 BLR waste w (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 200 | | | 1726 | 1726 | 156 | -0- | | 48 | -0- | | 19660 | | | 7 | | | 420 | 373 | 6 | EJ | 4500 | 593 |
| 2 | 200 | 497 | | 1072 | 1569 | 57 | | | 53 | — | | 22970 | | | 7 | | | 420 | 374 | 6 | EJ | 4882 | 674 |
| 3 | 200 | 700 | 895 | | 1595 | -0- | | | 51 | — | | 27360 | 7 | 7 | | 420 | 420 | | 376 | 6 | EJ | 5800 | — |
| 4 | 200 | 900 | 968 | | 1868 | — | — | | 46 | — | | 14630 | 7 | 7 | | 420 | 420 | | 378 | 3 | CZB | 5660 | — |
| 5 | 200 | 600 | 734 | 400 | 1774 | 55 | — | | 40 | — | | 15970 | — | — | 7 | — | — | 420 | 377 | 1 | CZB | 1506 | — |
| 6 | 200 | | | 1850 | 1850 | 252 | | | 47 | | | 19580 | | | 7 | | | 420 | 376 | 6 | EF | 1128 | 17 |
| 7 | 200 | | | 1590 | 1590 | 219 | — | | 56 | — | | 24220 | | | 7 | | | 420 | 375 | 6 | JW | 1408 | 53 |
| 8 | 200 | | | 1608 | 1608 | 214 | — | | 50 | — | | 25780 | | | 7 | | | 420 | 372 | 6 | W | 1421 | 56 |
| 9 | 200 | | | 2019 | 2019 | 268 | | | 37 | — | | 26590 | | | 7 | | | 420 | 374 | 6 | EJ | 1584 | 72 |
| 10 | 200 | | | 2040 | 2090 | 278 | | | 39 | — | | 26270 | | | 7 | | | 420 | 372 | 6 | W | 1187 | 39 |
| 11 | 200 | | | 1856 | 1856 | 242 | | | 50 | | | 27840 | | | 7 | | | 420 | 375 | 6 | EJ | 1781 | 96 |
| 12 | 200 | | | 1690 | 1690 | 205 | | | 56 | — | | 22680 | | | 7 | | | 420 | 376 | 6 | CZB | 2513 | 200 |
| 13 | 200 | | | 1707 | 1707 | 213 | | | 49 | | | 22050 | | | 7 | | | 420 | 374 | 6 | EJ | 2214 | 160 |
| 14 | 200 | | | 1808 | 1808 | 242 | | | 48 | | | 15020 | | | 7 | | | 420 | 373 | 6 | W | 1389 | 51 |
| 15 | 200 | | | 1923 | 1923 | 261 | 31,190 | | 36 | | | 21080 | | | 7 | | | 420 | 374 | 6 | EJ | 1252 | 31 |
| 16 | 200 | | | 2135 | 2135 | 288 | | 20 | 27 | | | 22930 | | | 7 | | | 420 | 372 | 6 | W | 1352 | 27 |
| 17 | 200 | | | 1912 | 1912 | 255 | | | 48 | | | 17550 | | | 7 | | | 420 | 373 | 6 | EJ | 1440 | 61 |
| 18 | 200 | | | 1974 | 1974 | 265 | | | 38 | | | 20730 | | | 7 | | | 420 | 372 | 6 | W | 1322 | 50 |
| 19 | 200 | | | 2227 | 2227 | 305 | | | 30 | | | 23850 | | | 7 | | | 420 | 374 | 6 | EJ | 2590 | 209 |
| 20 | 200 | | | 2223 | 2223 | 295 | | | 33 | | | 22130 | | | 7 | | | 420 | 375 | 6 | CZB | 1618 | 82 |
| 21 | 200 | | | 2085 | 2085 | 281 | | | 35 | | | 18870 | | | 7 | | | 425 | 372 | 6 | EJ | 1946 | 43 |
| 22 | 200 | | | 2038 | 2038 | 281 | | | 39 | | | 18690 | | | 7 | | | 425 | 372 | 6 | W | 1113 | 15 |
| 23 | 200 | | | 1990 | 1990 | 268 | | | 45 | | | 16020 | | | 7 | | | 425 | 372 | 6 | Dn | 1356 | 47 |
| 24 | 200 | | | 1800 | 1800 | 248 | | | 49 | | | 19140 | | | 7 | | | 425 | 375 | 6 | W | 1239 | 32 |
| 25 | 200 | | | 1678 | 1678 | 221 | | | 54 | | | 17180 | | | 7 | | | 425 | 375 | 6 | Dn | 1538 | 71 |
| 26 | 200 | | | 1561 | 1561 | 215 | | | 62 | | | 14130 | | | 7 | | | 420 | 378 | 6 | W | 1179 | 24 |
| 27 | 200 | | | 1579 | 1579 | 197 | | | 53 | | | 17120 | | | 7 | | | 425 | 375 | 6 | Dn | 2401 | 145 |
| 28 | 200 | | | 1520 | 1520 | 209 | | | 64 | | | 16330 | | | 7 | | | 425 | 377 | 6 | W | 2566 | 75 |
| 29 | 200 | | | 1547 | 1547 | 178 | | | 57 | | | 17580 | | | 7 | | | 425 | 375 | 6 | Dn | 2910 | 251 |
| 30 | 200 | | | 1721 | 1721 | 216 | | | 44 | | | 14480 | | | 7 | | | 425 | 378 | 6 | W | 2118 | 147 |
| 31 | 200 | | | 1867 | 1867 | 244 | | | 45 | | | 17570 | 70 | | 7 | | | 425 | 377 | 6 | Dn | 1696 | 92 |
| TOTAL | 6820 | 2197 | 2597 | 51156 | 55950 | 6628 | 31190 | | 1434 | | | 626120 | | | | | | | 11610 | 186 | | 66349 | |
| MAXIMUM | 220 | 900 | 968 | 2227 | 2227 | 305 | 31190 | | 64 | | | 27840 | | | | | | | 378 | 6 | | 5800 | |
| MINIMUM | 220 | 497 | 734 | 400 | 1520 | 55 | 31190 | | 27 | | | 14630 | | | | | | | 372 | 6 | | 1113 | |
| AVERAGE | 220 | 549 | 866 | 1764 | 1805 | 228.6 | 31190 | | 46 | | | 20197 | | | | | | | 375 | 6 | | 2140 | |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 5-98, 1 JUN 58, WHICH WILL BE USED.

A.5-86

## FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CENTRAL ENERGY PLANT | BLDG. NO. 1412 | MONTH: DECEMBER 1993

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 1 1,000 LB. (2) | BOILER 2 1,000 LB. (3) | BOILER 3 1,000 LB. (4) | TOTAL 1,000 LB. (5) | WOOD FEED TO BOILER 2,000 LB. (6) | NAT. GAS FUEL USED C.F. (7) | OIL LB. PER UNIT * (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. (10) | FEEDWATER TEMP. °F. (11) | MAKEUP GAL. (12) | %CO2 BOILER 1 (13) | %CO2 BOILER 2 (14) | %CO2 BOILER 3 (15) | FLUE GAS TEMP. BOILER 1 °F. (16) | BOILER 2 °F. (17) | BOILER 3 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | (22) | (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 220 | 794 | 1000 | | 1794 | | 1237960 | 1290 | 49 | 3.0 | 220 | 15770 | [illegible] | 7.4 | | 422 | 422 | | 373 | 6 | FW | | |
| 2 | 220 | 774 | 1000 | | 1774 | | 1190770 | 960 | 51 | 3.2 | 223 | 9850 | 7.4 | 7.4 | | 422 | 422 | | 374 | 6 | ELB | | |
| 3 | 220 | 737 | 1000 | | 1737 | | 1179640 | 840 | 56 | 3.0 | 220 | 15310 | 7.4 | 7.4 | | 422 | 422 | | [illegible] | 6 | FW | | |
| 4 | 220 | 734 | 900 | | 1634 | | 1081500 | 1110 | 66 | 3.0 | 220 | 14900 | 7.4 | 7.4 | | 422 | 422 | | 373 | 6 | FW | | |
| 5 | 220 | 773 | 900 | | 1673 | | 1106370 | 1210 | 61 | 3.0 | 220 | 13840 | 7.4 | 7.4 | | 422 | 422 | | 373 | 6 | FW | | |
| 6 | 220 | 751 | 900 | | 1691 | | 1119330 | 990 | 60 | 3.0 | 220 | 12440 | [illegible] | [illegible] | | 422 | 422 | | 373 | 6 | FW | | |
| 7 | 220 | 672 | 800 | 352 | 1824 | 48 | 983500 | 1260 | 50 | 3.0 | 220 | 12290 | [illegible] | 7.4 | 7.6 | 422 | 422 | 420 | 373 | 6 | FW | | |
| 8 | 220 | | | 1769 | 1769 | 232 | 10120 | 1410 | 50 | 3.0 | 220 | 11900 | | | 7.4 | | | 422 | 373 | 6 | FW | | |
| 9 | 220 | | | 1616 | 1616 | 223 | 46300 | 2030 | 51 | 3.1 | 221 | 10640 | | | 7.4 | | | 422 | 370 | 6 | ELB | | |
| 10 | 220 | | | 1589 | 1589 | 207 | 7380 | 1786 | 54 | 3.0 | 220 | 15020 | | | 7.4 | | | 422 | 375 | 6 | FW | | |
| 11 | 220 | | | 1866 | 1866 | 221 | 12850 | 2075 | 48 | 3.0 | 220 | 12230 | | | 7.4 | | | 422 | 370 | 6 | EF | | |
| 12 | 220 | | | 1701 | 1701 | 204 | 15050 | 1783 | 39 | 3.0 | 220 | 17440 | | | 7.4 | | | 422 | 373 | 6 | ELB | | |
| 13 | 220 | | | 1669 | 1669 | 190 | 7720 | 2328 | 39 | 3.0 | 220 | 18190 | | | 7.4 | | | 422 | 373 | 6 | EF | | |
| 14 | 220 | | | 1602 | 1602 | 174 | 10980 | 2741 | 51 | 3.0 | 220 | 17800 | | | 7.4 | | | 422 | 374 | 6 | ELB | | |
| 15 | 220 | | | 1416 | 1416 | 194 | 9560 | | 46 | 3.0 | 220 | 24350 | | | 7.4 | | | 422 | 375 | 6 | ELB | | |
| 16 | 220 | | | 1572 | 1572 | 137 | | 474 | 49 | 3.0 | 220 | 13560 | | | 7.4 | | | 422 | 374 | 6 | ELB | | |
| 17 | 220 | | | 1571 | 1571 | 174 | | 2513 | 49 | 3.0 | 220 | 14870 | | | 7.4 | | | 422 | 375 | 6 | EF | | |
| 18 | 220 | | | 1497 | 1497 | 178 | | 1665 | 54 | 3.0 | 220 | 14830 | | | 7.4 | | | 422 | 373 | 6 | [illegible] | | |
| 19 | 220 | | | 1595 | 1595 | 196 | | 1429 | 47 | 3.0 | 220 | 16290 | | | 7.4 | | | 422 | 374 | 6 | EF | | |
| 20 | 220 | | | 1729 | 1729 | 226 | | 730 | 48 | 3.0 | 220 | 17460 | | | 7.4 | | | 422 | 374 | 6 | EF | | |
| 21 | 220 | | | 1622 | 1622 | 223 | | | 48 | 3.0 | 220 | 18540 | | | 7.4 | | | 422 | 373 | 6 | EF | | |
| 22 | 220 | | | 1856 | 1856 | 245 | | 621 | 40 | 3.0 | 220 | 16060 | | | 7.4 | | | 422 | 374 | 6 | EF | | |
| 23 | 220 | | | 1923 | 1923 | 199 | | 1728 | 40 | 3.0 | 220 | 17860 | | | 7.4 | | | 422 | 373 | 6 | [illegible] | | |
| 24 | 220 | | | 1916 | 1916 | 234 | | 1781 | 36 | 3.0 | 220 | 14990 | | | 7.4 | | | 422 | 374 | 6 | EF | | |
| 25 | 220 | | | 1913 | 1930 | 237 | | 1690 | 42 | 3.0 | 220 | 17650 | | | 7.4 | | | 422 | 372 | 6 | [illegible] | | |
| 26 | 220 | | | 1875 | 1875 | 225 | | 1991 | 39 | 3.0 | 220 | 22880 | | | 7.4 | | | 422 | 373 | 6 | EF | | |
| 27 | 220 | | | 1810 | 1810 | 148 | | 998 | 49 | 3.0 | 220 | 21180 | | | 7.4 | | | 422 | 374 | 6 | [illegible] | | |
| 28 | 220 | | | 1664 | 1664 | 127 | | 840 | 53 | 3.01 | 220 | 27800 | | | 7.4 | | | 422 | 374 | 6 | [illegible] | | |
| 29 | 220 | | | 1594 | 1598 | 313 | | 1018 | 56 | 3.0 | 220 | 21840 | | | 7.4 | | | 422 | 375 | 6 | [illegible] | | |
| 30 | [illegible] | | | [illegible] | | | | [illegible] | | [illegible] | | | | | [illegible] | | | [illegible] | | | | | |
| 31 | 220 | | | 1833 | 1833 | [illegible] | | [illegible] | 37 | 3.0 | 220 | 20550 | | | 7.4 | | | 422 | 372 | 6 | [illegible] | | |
| TOTAL | 6820 | 5235 | 6500 | 41312 | 53047 | 4808 | 8219030 | 44212 | 1496 | 93.3 | 6824 | [illegible] | 51.8 | 51.8 | 185.2 | 2954 | 2954 | 10548 | 11578 | 186 | | | |
| MAXIMUM | 220 | 794 | 1000 | 1875 | 1875 | [illegible] | [illegible] | 2741 | 66 | 3.2 | 223 | 27800 | [illegible] | [illegible] | 7.6 | 422 | 422 | 422 | 375 | 6 | | | |
| MINIMUM | 220 | 672 | 800 | 352 | 1497 | 48 | [illegible] | 474 | 36 | 3.0 | 220 | 9850 | [illegible] | [illegible] | 7.4 | 422 | 422 | 420 | 370 | 6 | | | |
| AVERAGE | 220 | 748 | 929 | 1652 | 1711 | 192 | 534602 | 1426 | 48 | 3.0 | 220 | 17135 | [illegible] | [illegible] | 7.4 | 422 | 422 | 422 | 373 | 6 | | | |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 1730.88, OIL: 245.29, NAT. GAS: 330.7

REMARKS: * RECLAIMED [illegible] 29572, [illegible]

PREPARED BY | DATE 11 Jan 94 | APPROVED BY [illegible] | DATE 11 Jan 94 | POST ENGINEER | DATE

SEE REVERSE SIDE FOR INSTRUCTIONS

DA FORM

A.5-87

**FACILITIES ENGINEERING OPERATING LOG** *(Boiler Plant)*

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CENTRAL ENERGY PLANT

BLDG. NO.: 1412

MONTH: NOVEMBER 1993

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 1 1,000 LB. (2) | BOILER 2 1,000 LB. (3) | BOILER 4 1,000 LB. (4) | TOTAL 1,000 LB. (5) | WOOD TONS (6) | NAT. GAS FUEL USED C.F. (7) | NO. 2 OIL (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. (10) | FEEDWATER HEATER TEMP. °F. (11) | MAKEUP GAL. (12) | %CO2 BOILER 1 (13) | %CO2 BOILER 2 (14) | %CO2 BOILER 4 (15) | FLUE GAS TEMP. BOILER 1 °F. (16) | BOILER 2 °F. (17) | BOILER 4 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | (22) | (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 220 | 600 | 752 | | 1352 | | 60 | 11350 | 43 | 3.0 | 220 | 19980 | 7.4 | 7.4 | | 422 | 422 | | 375 | 3 | DR | | |
| 2 | 220 | 700 | 851 | | 1551 | | 1300 | 11350 | 46 | 3.0 | 220 | 23710 | 7.4 | 7.4 | | 422 | 422 | | 377 | 3 | WB | | |
| 3 | 220 | 700 | 809 | | 1509 | | 4570 | 11350 | 58 | 3.0 | 220 | 23970 | 7.4 | 7.4 | | 422 | 422 | | 374 | 3 | ARH | | |
| 4 | 220 | 700 | 820 | | 1520 | | 20 | 11350 | 66 | 3.0 | 220 | 23280 | 7.4 | 7.4 | | 422 | 422 | | 372 | 3 | ARH | | |
| 5 | 220 | 700 | 802 | | 1502 | | 4790 | 11350 | 67 | 3.0 | 220 | 19300 | 7.4 | 7.4 | | 422 | 422 | | 373 | 3 | FW | | |
| 6 | 220 | 700 | 798 | | 1498 | | 2070 | 11350 | 63 | 3.2 | 222 | 9580 | 7.4 | 7.4 | | 422 | 422 | | 374 | 3 | WB | | |
| 7 | 220 | 700 | 884 | | 1584 | | 3190 | 11350 | 47 | 3.0 | 222 | 15810 | 7.4 | 7.4 | | 422 | 422 | | 372 | 3 | ARH | | |
| 8 | 220 | 800 | 889 | | 1689 | | 3230 | 11350 | 47 | 3.0 | 222 | 20750 | 7.4 | 7.4 | | 422 | 422 | | 373 | 3 | FW | | |
| 9 | 220 | 800 | 925 | | 1725 | | 32440 | 11350 | 46 | 3.0 | 222 | 18250 | 7.4 | 7.4 | | 422 | 422 | | 372 | 3 | WB | | |
| 10 | 220 | 800 | 816 | | 1616 | | 3120 | 11350 | 48 | 3.1 | 222 | 10340 | 7.4 | 7.4 | | 422 | 422 | | 373 | 3 | HR | | |
| 11 | 220 | 800 | 833 | | 1633 | | 4680 | 11350 | 48 | 3.0 | 220 | 24770 | 7.4 | 7.4 | | 422 | 422 | | 374 | 3 | ARH | | |
| 12 | 220 | 800 | 838 | | 1638 | | 1480 | 11350 | 54 | 3.0 | 220 | 14190 | 7.4 | 7.4 | | 422 | 422 | | 374 | 3 | 7U | | |
| 13 | 220 | 700 | 842 | | 1542 | | 2430 | 11350 | 67 | 3.0 | 220 | 17460 | 7.4 | 7.4 | | 422 | 422 | | 374 | 3 | 7U | | |
| 14 | 220 | 700 | 770 | | 1470 | | 5350 | 11350 | 74 | 3.0 | 220 | 24400 | 7.4 | 7.4 | | 422 | 422 | | 374 | 3 | 7U | | |
| 15 | 220 | 700 | 787 | | 1487 | | 2850 | 11350 | 75 | 3.0 | 220 | 20310 | 7.4 | 7.4 | | 422 | 422 | | 374 | 3 | 7U | | |
| 16 | 220 | 700 | 772 | | 1472 | | 4030 | 11350 | 73 | 3.0 | 220 | 16900 | 7.4 | 7.4 | | 422 | 422 | | 374 | 3 | 7U | | |
| 17 | 220 | 700 | 729 | | 1429 | | 3420 | 11350 | 73 | 3.0 | 220 | 14650 | 7.4 | 7.0 | | 422 | 422 | | 373 | 3 | ARH | | |
| 18 | 220 | | 1031 | 440 | 1471 | 50 | 1700 | 11350 | 70 | 3.0 | 220 | 12120 | | 7.4 | 7.6 | | 422 | 420 | 374 | 3 | ARH | | |
| 19 | 220 | | 501 | 838 | 1339 | 150 | 387260 | 162 | 69 | 3.2 | 222 | 9870 | | 7.5 | 7.5 | | 421 | 421 | 373 | 3 | FW | | |
| 20 | 220 | 700 | 828 | | 1528 | | 1081190 | | 56 | 3.0 | 220 | 13190 | 7.4 | 7.4 | | 422 | 422 | | 374 | 3 | FW | | |
| 21 | 220 | 800 | 893 | | 1693 | | 1205800 | | 50 | 3.0 | 220 | 11260 | 7.4 | 7.4 | | 422 | 422 | | 373 | 3 | 7U | | |
| 22 | 220 | 800 | 951 | | 1751 | | 1156160 | | 56 | 3.1 | 221 | 10090 | 7.4 | 7.4 | | 422 | 422 | | 373 | 3 | 7U | | |
| 23 | 220 | 800 | 888 | | 1688 | | 1108170 | | 58 | 3.0 | 221 | 11110 | 7.4 | 7.4 | | 422 | 422 | | 373 | 3 | FW | | |
| 24 | 220 | 800 | 819 | | 1619 | | 1013580 | | 60 | 3.0 | 220 | 14170 | 7.4 | 7.4 | | 422 | 422 | | 372 | 3 | ARH | | |
| 25 | 220 | 800 | 862 | | 1662 | | 1114400 | | 61 | 3.0 | 220 | 12560 | 7.4 | 7.4 | | 422 | 422 | | 374 | 3 | ARH | | |
| 26 | 220 | 800 | 876 | | 1676 | | 1126280 | | 58 | 3.0 | 220 | 15940 | 7.4 | 7.4 | | 422 | 422 | | 373 | 3 | FW | | |
| 27 | 220 | 800 | 826 | | 1626 | | 1110000 | | 63 | 3.0 | 220 | 12950 | 7.4 | 7.4 | | 422 | 422 | | 374 | 3 | 7U | | |
| 28 | 220 | 800 | 892 | | 1692 | | 1133920 | | 50 | 3.0 | 220 | 12990 | 7.4 | 7.4 | | 422 | 422 | | 373 | 3 | FW | | |
| 29 | 220 | 800 | 989 | | 1789 | | 1228540 | | 46 | 3.0 | 220 | 12610 | 7.4 | 7.4 | | 422 | 422 | | 372 | 3 | 7W | | |
| 30 | 220 | 800 | 991 | | 1791 | | 1214330 | | 50 | 3.0 | 220 | 11060 | 7.4 | 7.4 | | 422 | 422 | | 372 | 3 | 7U | | |
| 31 | | | | | | | | | | | | 570 | | | | | | | | | | | |
| TOTAL | 6600 | 21000 | 25264 | 1278 | 47542 | 200 | 12960310 | 204062 | 1742 | 90.6 | 6614 | 477660 | 207.2 | 223 | 15.1 | 11816 | 12659 | 841 | 11202 | 4 | | | |
| MAXIMUM | 220 | 800 | 1031 | 838 | 1791 | 150 | 1228540 | 11350 | 75 | 3.2 | 222 | 23970 | 7.4 | 7.5 | 7.6 | 422 | 422 | 421 | 375 | 3 | | | |
| MINIMUM | 220 | 600 | 501 | 440 | 1339 | 50 | 20 | 162 | 43 | 3.0 | 220 | 9580 | 7.4 | 7.4 | 7.5 | 422 | 421 | 420 | 372 | 3 | | | |
| AVERAGE | 220 | 750 | 842 | 639 | 1585 | 100 | 432010 | 16761 | 50 | 3.02 | 220.5 | 15922 | 7.4 | 7.4 | 7.55 | 422 | 422 | 420.5 | 373 | 3 | | | |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 72, NO.2 OIL: 1134.36, N.G: 534.47

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: [illegible signature] DATE: 20 Dec 93

APPROVED BY: Randy A. Parks DATE: 20 Dec 93

POST ENGINEER DATE

DA FORM 2067

A.5-88

# FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CENTRAL ENERGY PLANT

BLDG. NO. 1412

MONTH: OCTOBER 1993

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 1 1,000 LB. (2) | BOILER 2 1,000 LB. (3) | BOILER 4 1,000 LB. (4) | TOTAL 1,000 LB. (5) | WOOD TONS (6) | OIL FUEL USED * GAL. (7) | NAT. GAS (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. (10) | FEEDWATER HEATER TEMP. °F. (11) | MAKEUP GAL. (12) | %CO2 BOILER 1 (13) | %CO2 BOILER 2 (14) | %CO2 BOILER 4 (15) | FLUE GAS TEMPERATURE BOILER 1 °F. (16) | BOILER 2 °F. (17) | BOILER 4 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | (22) | (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 220 | | | 711 | 711 | 147 | | 2700 | 62 | 3.0 | 220 | 12050 | | | 7.6 | | | 420 | 383 | 6 | [illegible] | | |
| 2 | 220 | | | 1174 | 1174 | 112 | | 5660 | 67 | 3.2 | 222 | 4700 | | | 7.5 | | | [illegible] | [illegible] | [illegible] | [illegible] | | |
| 3 | 220 | | | 1227 | 1227 | 167 | | 3630 | 73 | 3.0 | 222 | 13030 | | | 7.4 | | | 422 | 383 | 6 | DR | | |
| 4 | 220 | | | 1451 | 1451 | 151 | 1738 | 13210 | 78 | 3.2 | 223 | 9870 | | | 7.4 | | | 422 | 384 | 6 | ELB | | |
| 5 | 220 | | | 1637 | 1637 | 152 | 4530 | 8490 | 75 | 3.1 | 222 | 10180 | | | 7.4 | | | 422 | 380 | 6 | WJS | | |
| 6 | 220 | | | 1324 | 1324 | 169 | 624 | 54360 | 69 | 3.0 | 220 | 17930 | | | 7.4 | | | 422 | 381 | 6 | WJS | | |
| 7 | 220 | | | 1686 | 1686 | 125 | 2365 | 5010 | 65 | 3.0 | 220 | 11340 | | | 7.4 | | | 422 | 380 | 6 | WJS | | |
| 8 | 220 | | | 1639 | 1639 | 118 | 3357 | 3570 | 71 | 3.1 | 222 | 9940 | | | 7.4 | | | 422 | 380 | 6 | DR | | |
| 9 | 220 | | | 1582 | 1582 | 153 | 445 | 70 | 73 | 3.0 | 220 | 12920 | | | 7.4 | | | 422 | 381 | 6 | ELB | | |
| 10 | 220 | | | 1640 | 1640 | 185 | | 160 | 80 | 3.0 | 220 | 12930 | | | 7.4 | | | 422 | 380 | 6 | ELB | | |
| 11 | 220 | 600 | 794 | | 1394 | | 9512 | 50 | 61 | 3.0 | 220 | 11560 | 7.5 | 7.4 | | 421 | 422 | | 380 | 3 | ELB | | |
| 12 | 220 | 672 | 600 | | 1272 | | 9512 | 9920 | 62 | 3.0 | 220 | 13700 | 7.4 | 7.5 | | 422 | 421 | | 380 | 3 | RP | | |
| 13 | 220 | 652 | 600 | | 1252 | | 9512 | | 60 | 3.0 | 220 | 11490 | 7.4 | 7.5 | | 422 | 421 | | 380 | 3 | EJ | | |
| 14 | 220 | 627 | 600 | | 1227 | | 9512 | | 65 | 3.2 | 222 | 9810 | 7.4 | 7.5 | | 422 | 421 | | 380 | 3 | EJ | | |
| 15 | 220 | 600 | 671 | | 1271 | | 9500 | 50 | 68 | 3.0 | 220 | 11030 | 7.5 | 7.4 | | 421 | 422 | | 382 | 3 | ELB | | |
| 16 | 220 | 684 | 600 | | 1284 | | 9524 | | 67 | 3.1 | 221 | 10470 | 7.4 | 7.5 | | 422 | 421 | | 381 | 3 | GR | | |
| 17 | 220 | 625 | 625 | | 1250 | | 9524 | | 69 | 3.0 | 220 | 13630 | 7.4 | 7.4 | | 422 | 422 | | 379 | 3 | ELB | | |
| 18 | 220 | 650 | 735 | | 1385 | | 9500 | 4430 | 74 | 3.0 | 220 | 12970 | 7.4 | 7.4 | | 422 | 422 | | 380 | 3 | DR | | |
| 19 | 220 | 650 | 748 | | 1398 | | 9512 | 40 | 74 | 3.0 | 220 | 16120 | 7.4 | 7.4 | | 422 | 422 | | 380 | 3 | ELB | | |
| 20 | 220 | 600 | 788 | | 1388 | | 9512 | 3390 | 76 | 3.0 | 220 | 16440 | 7.5 | 7.4 | | 421 | 422 | | 380 | 3 | EJ | | |
| 21 | 220 | 700 | 787 | | 1487 | | 9512 | 2530 | 74 | 3.0 | 220 | 16250 | 7.4 | 7.4 | | 422 | 422 | | 380 | 3 | EJ | | |
| 22 | 220 | 650 | 726 | | 1376 | | 9500 | 10 | 69 | 3.1 | 221 | 9730 | 7.4 | 7.4 | | 422 | 422 | | 380 | 3 | RP | | |
| 23 | 220 | 600 | 720 | | 1320 | | 9524 | 100 | 55 | 3.0 | 220 | 12290 | [illegible] | [illegible] | | 421 | 422 | | [illegible] | 3 | ELB | | |
| 24 | 220 | 650 | 720 | | 1370 | | 9524 | | 56 | 3.0 | 220 | 11200 | [illegible] | [illegible] | | 422 | [illegible] | | 379 | 3 | WJS | | |
| 25 | 220 | 619 | 750 | | 1369 | | 9500 | 20 | 65 | 3.3 | 224 | 7500 | 7.4 | 7.4 | | 422 | 422 | | 379 | 3 | [illegible] | | |
| 26 | 220 | 613 | 750 | | 1363 | | 9512 | 10 | 62 | 3.0 | 220 | 13800 | 7.4 | 7.4 | | 422 | 422 | | [illegible] | [illegible] | [illegible] | | |
| 27 | 220 | 627 | 750 | | 1377 | | 9512 | | 65 | 3.0 | 220 | 13280 | 7.4 | 7.4 | | 422 | 422 | | 378 | 3 | WJS | | |
| 28 | 220 | 600 | 602 | | 1202 | | 9512 | | 60 | 3.0 | 220 | 13230 | 7.5 | 7.5 | | 421 | [illegible] | | [illegible] | [illegible] | [illegible] | | |
| 29 | 220 | 500 | 699 | | 1199 | | 9500 | | 55 | 3.0 | 220 | 13790 | 7.5 | 7.4 | | 421 | 422 | | 377 | 3 | EJ | | |
| 30 | 220 | 500 | 642 | | 1142 | | 9524 | 50 | 66 | 3.0 | 220 | 14070 | 7.5 | 7.4 | | 421 | 422 | | 379 | [illegible] | ALH | | |
| 31 | 220 | 612 | 600 | | 1212 | | 9512 | 10 | 48 | 3.0 | 220 | 19120 | 7.5 | 7.4 | | 421 | 422 | | 377 | 3 | [illegible] | | |
| TOTAL | 6820 | 13031 | 14407 | 14[illegible] | 41509 | 1523 | 212802 | 117470 | 2065 | 94.3 | 6838 | 385750 | 156.2 | 155.8 | 74.3 | 8854 | 8859 | 4217 | 11781 | 123 | | | |
| MAXIMUM | 220 | 700 | 794 | 1686 | 1686 | 169 | 9524 | 54360 | 80 | 3.3 | 224 | 19420 | 7.5 | 7.5 | 7.6 | 422 | 422 | 422 | 384 | 6 | | | |
| MINIMUM | 220 | 500 | 600 | 711 | 711 | 112 | 445 | 10 | 56 | 3.0 | 220 | 7500 | 7.4 | 7.4 | 7.4 | 421 | 421 | 420 | 377 | 3 | | | |
| AVERAGE | 220 | 621 | 686 | 1467 | 1339 | 153 | 7600 | 5107 | 67 | 3.04 | 220.6 | 12444 | 7.44 | 7.42 | 7.43 | 421.6 | 421.8 | 421.7 | 380 | 3.97 | | | |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)
WOOD: 550.44, OIL: 1180.63, NAT. GAS: 4.85

REMARKS 391750
*=Reclaimed oil F.S.: 13051 GL, NO. 2 [illegible]: 174751 GL

PREPARED BY [illegible signature] | DATE 3 Nov [illegible]

APPROVED BY | DATE | POST ENGINEER | DATE

SEE REVERSE SIDE FOR INSTRUCTIONS

DA FORM 2067

A.5-89

# FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313
PLANT: CENTRAL ENERGY PLANT
BLDG. NO.: 1412
MONTH: SEPTEMBER, 1993

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 1 1,000 LB. (2) | BOILER 2 1,000 LB. (3) | BOILER 3 1,000 LB. (4) | TOTAL 1,000 LB. (5) | WOOD TONS 2,000 LB. (6) | OIL FUEL USED * GAL. (7) | NAT. GAS (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. (10) | TEMP. °F. (11) | MAKEUP GAL. (12) | %CO2 BOILER 1 (13) | %CO2 BOILER 2 (14) | %CO2 BOILER 3 (15) | FLUE GAS TEMPERATURE BOILER 1 °F. (16) | BOILER 2 °F. (17) | BOILER 3 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | (22) | (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 220 | | | 1795 | 1795 | 343 | 2266 | 15350 | 84 | 3.0 | 220 | 13990 | | | 7.4 | | | 422 | 384 | 6 | MW | | |
| 2 | 220 | | | 1864 | 1864 | 350 | 2348 | 2860 | 84 | 3.0 | 220 | 11990 | | | 7.4 | | | 422 | 383 | 6 | wB | | |
| 3 | 220 | | | 1557 | 1557 | 198 | 2152 | 12430 | 86 | 3.0 | 220 | 12520 | | | 7.4 | | | 422 | 384 | 6 | aJH | | |
| 4 | 220 | | | 1800 | 1800 | 346 | 6023 | 14240 | 85 | 3.1 | 221 | 10900 | | | 7.4 | | | 422 | 383 | 6 | PL | | |
| 5 | 220 | | | 1737 | 1737 | 263 | 4498 | 8060 | 82 | 3.0 | 220 | 12610 | | | 7.4 | | | 422 | 384 | 6 | aJH | | |
| 6 | 220 | | | 1828 | 1828 | 296 | 3276 | 10840 | 82 | 3.0 | 220 | 15450 | | | 7.4 | | | 422 | 384 | 6 | PL | | |
| 7 | 220 | 12 | | 1839 | 1851 | 327 | 2138 | 28370 | 74 | 3.0 | 220 | 12290 | 7.6 | | 7.4 | 420 | | 422 | 382 | 6 | aJH | | |
| 8 | 220 | | | 1929 | 1929 | 344 | 1850 | 5530 | 78 | 3.2 | 222 | 9010 | | | 7.4 | | | 422 | 382 | 6 | MW | | |
| 9 | 220 | | | 1918 | 1918 | 356 | 1875 | 8580 | 79 | 3.0 | 220 | 12550 | | | 7.4 | | | 422 | 384 | 6 | MW | | |
| 10 | 220 | | 115 | 1719 | 1834 | 328 | 2550 | 14400 | 84 | 3.1 | 221 | 10250 | | 7.6 | 7.4 | | 420 | 422 | 384 | 6 | PL | | |
| 11 | 220 | | | 1772 | 1772 | 332 | 2050 | 110 | 75 | 3.0 | 220 | 13230 | | | 7.4 | | | 422 | 383 | 6 | aJH | | |
| 12 | 220 | | | 1752 | 1752 | 241 | 1800 | 288 | 76 | 3.0 | 220 | 12150 | | | 7.4 | | | 422 | 382 | 6 | PL | | |
| 13 | 220 | | 971 | 686 | 1657 | 192 | 2220 | 350 | 77 | 3.0 | 220 | 14510 | | 7.4 | 7.6 | | 422 | 420 | 384 | 6 | aJH | | |
| 14 | 220 | 900 | 807 | | 1707 | | 2500 | 390 | 80 | 3.0 | 220 | 13360 | 7.4 | 7.4 | | 422 | 422 | | 382 | 6 | EW | | |
| 15 | 220 | 900 | 723 | | 1623 | | 1000 | 110 | 82 | 3.0 | 220 | 13840 | 7.4 | 7.5 | | 422 | 421 | | 383 | 6 | ET | | |
| 16 | 220 | 800 | 896 | | 1696 | | 1800 | 307520 | 87 | 3.0 | 220 | 12930 | 7.4 | 7.4 | | 422 | 422 | | 384 | 6 | ET | | |
| 17 | 220 | 800 | 912 | – | 1712 | | 2100 | 1257760 | 81 | 3.2 | 223 | 8570 | 7.4 | 7.4 | | 422 | 422 | | 383 | | aJH | | |
| 18 | 220 | 700 | 742 | | 1442 | | 1200 | 705823 | 82 | 3.0 | 220 | 12550 | 7.5 | 7.5 | | 421 | 421 | | 384 | | ELB | | |
| 19 | 220 | 800 | 813 | | 1613 | | 1300 | 1159000 | 81 | 3.1 | 222 | 10440 | 7.4 | 7.4 | | 422 | 422 | | 383 | | DR | | |
| 20 | 220 | 800 | 983 | | 1783 | | 1600 | 1367810 | 79 | 3.4 | 225 | 6310 | 7.4 | 7.4 | | 422 | 422 | | 383 | | ELB | | |
| 21 | 220 | 800 | 965 | | 1765 | | 1800 | 1260830 | 79 | 3.0 | 220 | 11060 | 7.4 | 7.4 | | 422 | 422 | | 384 | | LR | | |
| 22 | 220 | 800 | 907 | | 1707 | | 1850 | 1182490 | 77 | 3.1 | 221 | 10510 | 7.4 | 7.4 | | 422 | 422 | | 383 | | aJH | | |
| 23 | 220 | 800 | 871 | | 1671 | | 1800 | 1189030 | 75 | 3.2 | 222 | 9220 | 7.4 | 7.4 | | 422 | 422 | | 383 | | wB | | |
| 24 | 220 | 800 | 861 | | 1661 | | 1200 | 1180540 | 84 | 3.2 | 223 | 8430 | 7.4 | 7.4 | | 422 | 422 | | 383 | | ELB | | |
| 25 | 220 | 800 | 916 | | 1716 | | 1600 | 1220080 | 82 | 3.0 | 220 | 17800 | 7.4 | 7.4 | | 422 | 422 | | 384 | | LR | | |
| 26 | 220 | 800 | 829 | | 1629 | | 1400 | 1219910 | 86 | 3.0 | 220 | 15760 | 7.4 | 7.4 | | 422 | 422 | | 384 | | ELB | | |
| 27 | 220 | 800 | 873 | | 1673 | | 1400 | 1187930 | 81 | 3.1 | 221 | 10750 | 7.4 | 7.4 | | 422 | 422 | | 384 | | DR | | |
| 28 | 220 | 600 | 603 | | 1203 | | 1400 | 857750 | 67 | 3.1 | 221 | 10540 | 7.5 | 7.5 | | 421 | 421 | | 383 | | ELB | | |
| 29 | 220 | 500 | 601 | | 1101 | | 1500 | 875480 | 66 | 3.0 | 221 | 17160 | 7.5 | 7.5 | | 421 | 421 | | 382 | | wB | | |
| 30 | 220 | | 507 | 627 | 1134 | 179 | 1560 | 327860 | 62 | 3.2 | 223 | 8140 | | 7.5 | 7.5 | | 421 | 421 | 781 | | LB | | |
| 31 | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | 6600 | 13212 | 15890 | | 51925 | 3995 | 62065 | 15997620 | 2376 | 92.0 | 6626 | 359006 (→358820) | 126.3 | 141.3 | 103.9 | 7169 | 8011 | 5905 | 11496 | 96 | | | |
| MAXIMUM | 220 | 900 | 983 | | 1929 | 363 | 6032 | 1260830 | 87 | 3.4 | 225 | 17160 | 7.6 | 7.6 | 7.6 | 422 | 422 | 422 | 384 | 6 | | | |
| MINIMUM | 220 | 12 | 115 | | 1101 | 179 | 1000 | 110 | 62 | 3.0 | 220 | 6310 | 7.4 | 7.4 | 7.4 | 420 | 420 | 420 | 381 | 6 | | | |
| AVERAGE | 220 | 734 | 795 | | 1731 | 285 | 2059 | 533236 | 79 | 3.07 | 220.8 | 11967 | 7.43 | 7.44 | 7.42 | 421.7 | 421.6 | 421.8 | 383 | 6 | | | |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 1438.2, OIL: 344.34, NAT. GAS: 659.72

REMARKS: *= Reclaimed oil F.S.: 16745, NO. 2 OIL: 45320

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: Wayne L. [signature] DATE: 10 Oct 93

APPROVED BY: [signature] DATE: 12 Oct 93

POST ENGINEER / DATE

DA FORM

A.5-90

# FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CENTRAL ENERGY PLANT

BLDG. NO.: 1412

MONTH: AUGUST 1993

| DATE | STEAM PRODUCED: STEAM PRESSURE LB. (1) | BOILER 1 1,000 LB. (2) | BOILER 2 1,000 LB. (3) | BOILER 3 1,000 LB. (4) | TOTAL 1,000 LB. (5) | WOOD TONS 2,000 LB. (6) | OIL FUEL USED GAL. * (7) | NAT. GAS CU. FT. (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. (10) | FEEDWATER HEATER TEMP. °F. (11) | MAKEUP GAL. (12) | %CO2 BOILER 1 (13) | %CO2 BOILER 2 (14) | %CO2 BOILER 3 (15) | FLUE GAS TEMPERATURE BOILER 1 °F. (16) | FLUE GAS BOILER 2 °F. (17) | FLUE GAS BOILER 3 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | (22) | (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 220 | | 663 | 1147 | 1810 | 105 | 400 | 422890 | 88 | 3.1 | 221 | 10560 | | 7.5 | 7.5 | | 421 | 421 | 383 | 6 | HEB | | |
| 2 | 220 | | 674 | 1228 | 1899 | 105 | 400 | 487400 | 92 | 3.0 | 220 | 12220 | | 7.5 | 7.4 | | 421 | 422 | 384 | 6 | HEB | | |
| 3 | 220 | | 672 | 1215 | 1887 | 105 | 400 | 487780 | 90 | 3.1 | 221 | 10070 | | 7.5 | 7.4 | | 421 | 422 | 383 | 6 | HEB | | |
| 4 | 220 | | 677 | 1191 | 1868 | 105 | 400 | 531020 | 88 | 3.1 | 221 | 10050 | | 7.5 | 7.4 | | 421 | 422 | 383 | 6 | FW | | |
| 5 | 220 | | 612 | 1208 | 1820 | 105 | 400 | 480500 | 82 | 3.2 | 223 | 8970 | | 7.5 | 7.4 | | 421 | 422 | 382 | 6 | FU | | |
| 6 | 220 | | 549 | 1314 | 1863 | 105 | 1074 | 429280 | 86 | 3.1 | 221 | 10750 | | 7.5 | 7.4 | | 421 | 422 | 384 | 6 | HEB | | |
| 7 | 220 | | 435 | 1377 | 1812 | 105 | 3731 | 344266 | 83 | 3.1 | 221 | 10480 | | 7.5 | 7.4 | | 421 | 422 | 383 | 6 | QLH | | |
| 8 | 220 | | 361 | 1485 | 1846 | 105 | 3716 | 290500 | 83 | 3.0 | 220 | 15120 | | 7.5 | 7.4 | | 421 | 422 | 383 | 6 | WS | | |
| 9 | 220 | | 472 | 1377 | 1849 | 105 | 2665 | 362820 | 79 | 3.0 | 220 | 13750 | | 7.5 | 7.4 | | 421 | 422 | 384 | 6 | QLH | | |
| 10 | 220 | | 704 | 1171 | 1875 | 105 | 1200 | 514970 | 80 | 3.0 | 220 | 12340 | | 7.4 | 7.4 | | 422 | 422 | 384 | 6 | WS | | |
| 11 | 220 | | 658 | 1194 | 1852 | 105 | 200 | 514430 | 80 | 3.0 | 220 | 12470 | | 7.5 | 7.4 | | 421 | 422 | 384 | 6 | MW | | |
| 12 | 220 | | 545 | 1267 | 1812 | 105 | 200 | 436120 | 82 | 3.0 | 220 | 11780 | | 7.5 | 7.4 | | 421 | 422 | 383 | 6 | EZ | | |
| 13 | 228 | | 637 | 1156 | 1793 | 105 | 200 | 494900 | 88 | 3.0 | 220 | 11900 | | 7.5 | 7.4 | | 421 | 422 | 384 | 6 | QLH | | |
| 14 | 220 | | | 1816 | 1816 | 105 | 200 | 2620 | 83 | 3.1 | 221 | 10400 | | | 7.4 | | | 422 | 385 | 6 | WS | | |
| 15 | 220 | | | 1819 | 1819 | 105 | 200 | 11000 | 82 | 3.0 | 220 | 11780 | | | 7.4 | | | 422 | 385 | 6 | HEB | | |
| 16 | 220 | | | 1831 | 1831 | 101 | 200 | 28860 | 80 | 3.1 | 220 | 10050 | | | 7.4 | | | 422 | 385 | 6 | HEB | | |
| 17 | 220 | | 172 | 1622 | 1794 | 100 | 200 | 159330 | 86 | 3.0 | 220 | 12320 | | 7.6 | 7.4 | | 420 | 422 | 385 | 6 | HEB | | |
| 18 | 220 | | | 1732 | 1732 | 100 | 200 | 18260 | 86 | 3.0 | 220 | 11710 | | | 7.4 | | | 422 | 385 | 6 | MW | | |
| 19 | 220 | 109 | | 1631 | 1740 | 100 | 200 | 119630 | 83 | 3.0 | 220 | 16480 | 7.6 | | 7.4 | 420 | | 422 | 385 | 6 | EZ | | |
| 20 | 220 | 20 | | 1707 | 1727 | 100 | 200 | 50600 | 83 | 3.0 | 220 | 11350 | 7.6 | | 7.4 | 420 | | 422 | 384 | 6 | QLH | | |
| 21 | 220 | | | 1772 | 1772 | 100 | 200 | 7820 | 91 | 3.1 | 221 | 10950 | | | 7.4 | | | 422 | 382 | 6 | WB | | |
| 22 | 220 | | | 1788 | 1788 | 100 | 200 | 21590 | 86 | 3.0 | 220 | 14100 | | | 7.4 | | | 422 | 384 | 6 | QR | | |
| 23 | 220 | | | 1796 | 1796 | 100 | 200 | 19710 | 83 | 3.0 | 220 | 12340 | | | 7.4 | | | 422 | 382 | 6 | FW | | |
| 24 | 220 | | | 1827 | 1827 | 100 | 200 | 17660 | 79 | 3.0 | 220 | 15240 | | | 7.4 | | | 422 | 384 | 6 | QLH | | |
| 25 | 220 | | | 1819 | 1819 | 100 | 246 | 14540 | 82 | 3.0 | 220 | 16510 | | | 7.4 | | | 422 | 385 | 6 | BR | | |
| 26 | 220 | | | 1751 | 1752 | 100 | 288 | 27830 | 79 | 3.0 | 220 | 18270 | | | 7.4 | | | 422 | 385 | 6 | MW | | |
| 27 | 220 | | | 1805 | 1805 | 100 | 129 | 24780 | 83 | 3.0 | 220 | 17960 | | | 7.4 | | | 422 | 383 | 6 | WS | | |
| 28 | 220 | | | 1820 | 1820 | 100 | 206 | 8160 | 77 | 3.0 | 220 | 21740 | | | 7.4 | | | 422 | 382 | 6 | QLH | | |
| 29 | 220 | | | 1823 | 1823 | 100 | 912 | 7440 | 82 | 3.0 | 220 | 21140 | | | 7.4 | | | 422 | 383 | 6 | PL | | |
| 30 | 220 | 150 | | 1611 | 1761 | 100 | 79 | 110370 | 79 | 3.0 | 220 | 26530 | 7.6 | | 7.4 | | | 422 | 382 | 6 | QLH | | |
| 31 | 220 | | | 1819 | 1819 | 100 | 82 | 7140 | 82 | | | 23240 | | | 7.4 | | | 422 | 382 | 6 | PL | | |
| TOTAL | 6820 | 279 | 7831 | 48120 | 56230 | 3176 | 19130 | 6454210 | 2583 | 94.0 | 6830 | 432570 | 22.8 | 105.0 | 229.5 | 840 | 5894 | 13081 | 11891 | 186 | | | |
| MAXIMUM | 220 | 150 | 704 | 1831 | 1899 | 105 | 3716 | 531020 | 92 | 3.2 | 223 | 26530 | 7.6 | 7.6 | 7.5 | 420 | 422 | 422 | 382 | 6 | | | |
| MINIMUM | 220 | 20 | 172 | 1147 | 1727 | 100 | 42 | 2620 | 77 | 3.0 | 220 | 8970 | 7.6 | 7.4 | 7.4 | 420 | 420 | 421 | 385 | 6 | | | |
| AVERAGE | 220 | 93 | 559 | 1552 | 1814 | 102.5 | 617 | 208200 | 83 | 3.03 | 220.3 | 13954 | 7.6 | 7.5 | 7.4 | 420 | 421 | 422 | 384 | 6 | | | |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 1143.36, OIL: 106.13, NAT. GAS: 266.16

REMARKS: * Reclaimed OiL F.S.: 11,186 GL., NO. 2 OIL: 7,944

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: Wayne L. Bowman | DATE: 9 Sep 93

APPROVED BY: Randy A. Parks | DATE: 9 Sept 93

POST ENGINEER | DATE

DA FORM 3067

A.5-91

# FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CENTRAL ENERGY PLANT

BLDG. NO. 1412

MONTH: JULY 1993

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 4 1,000 LB. (2) | BOILER 2 1,000 LB. (3) | BOILER 3 1,000 LB. (4) | TOTAL 1,000 LB. (5) | WOOD TONS 2,000 LB. (6) | OIL FUEL USED * GAL. (7) | OUTSIDE EVAP. LB. PER UNIT AVG. TEMP. (8) | NAT. GAS CU. FT (9) | FEEDWATER HEATER PRESS. LB. (10) | FEEDWATER HEATER TEMP. °F. (11) | MAKEUP GAL. (12) | %CO2 BOILER 4 (13) | %CO2 BOILER 2 (14) | %CO2 BOILER 3 (15) | FLUE GAS TEMPERATURE BOILER 4 °F. (16) | BOILER 2 °F. (17) | BOILER 3 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | (22) | (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 220 | 841 | 777 | | 1618 | 167 | 100 | 84 | 695000 | 3.0 | 220 | 14560 | 7.4 | 7.4 | | 422 | 422 | | 380 | 6 | 7U | | |
| 2 | 220 | 862 | 748 | | 1590 | 163 | 100 | 87 | 672280 | 3.1 | 221 | 10290 | 7.4 | 7.4 | | 422 | 422 | | 385 | 6 | HEB | | |
| 3 | 220 | 742 | 806 | | 1548 | 168 | 100 | 91 | 441600 | 3.0 | 220 | 14220 | 7.5 | 7.4 | | 421 | 422 | | 384 | 6 | HEB | | |
| 4 | 220 | 803 | 780 | | 1583 | 169 | 100 | 88 | 623590 | 3.0 | 220 | 14180 | 7.5 | 7.4 | | 421 | 422 | | 385 | 6 | HEB | | |
| 5 | 220 | 816 | 787 | | 1603 | 161 | 100 | 88 | 612010 | 3.0 | 220 | 13620 | 7.5 | 7.4 | | 421 | 422 | | 384 | 6 | HEB | | |
| 6 | 220 | 905 | 778 | | 1683 | 173 | 100 | 89 | 655730 | 3.0 | 220 | 13900 | 7.4 | 7.4 | | 422 | 422 | | 384 | 6 | HEB | | |
| 7 | 220 | 980 | 786 | | 1764 | 133 | 100 | 87 | 652800 | 3.0 | 220 | 14670 | 7.4 | 7.4 | | 422 | 422 | | 384 | 6 | FW | | |
| 8 | 220 | 1035 | 765 | | 1800 | 168 | 100 | 84 | 688000 | 3.0 | 220 | 13390 | 7.4 | 7.4 | | 422 | 422 | | 383 | 6 | FW | | |
| 9 | 220 | 1020 | 775 | | 1795 | 140 | 100 | 86 | 637310 | 3.0 | 220 | 14630 | 7.4 | 7.4 | | 422 | 422 | | 385 | 6 | MW | | |
| 10 | 220 | 999 | 786 | | 1785 | 136 | 100 | 91 | 657920 | 3.0 | 220 | 12170 | 7.4 | 7.4 | | 422 | 422 | | 384 | 6 | MW | | |
| 11 | 220 | 1002 | 771 | | 1773 | 137 | 100 | 86 | 662170 | 3.0 | 220 | 12960 | 7.4 | 7.4 | | 422 | 422 | | 382 | 6 | WB | | |
| 12 | 220 | 966 | 830 | | 1796 | 181 | 100 | 86 | 636960 | 3.0 | 220 | 14450 | 7.4 | 7.4 | | 422 | 422 | | 381 | 6 | WB | | |
| 13 | 220 | 956 | 824 | | 1780 | 132 | 100 | 86 | 650250 | 3.0 | 220 | 15640 | 7.4 | 7.4 | | 422 | 422 | | 382 | 6 | WB | | |
| 14 | 220 | 1048 | 792 | | 1840 | 142 | 100 | 87 | 580400 | 3.0 | 220 | 13770 | 7.4 | 7.4 | | 422 | 422 | | 381 | 6 | FW | | |
| 15 | 220 | 1095 | 666 | | 1761 | 150 | 100 | 86 | 491800 | 3.0 | 220 | 14600 | 7.4 | 7.5 | | 422 | 421 | | 382 | 6 | FW | | |
| 16 | 220 | 1219 | 662 | | 1821 | 140 | 1673 | 92 | 402780 | 3.0 | 220 | 16030 | 7.4 | 7.5 | | 422 | 421 | | 384 | 6 | HEB | | |
| 17 | 220 | 1235 | 623 | | 1858 | 147 | 1394 | 90 | 521840 | 3.0 | 220 | 14040 | 7.4 | 7.5 | | 422 | 421 | | 384 | 6 | HEB | | |
| 18 | 220 | 1283 | 541 | | 1824 | 150 | 1601 | 91 | 455250 | 3.0 | 220 | 14160 | 7.4 | 7.5 | | 422 | 421 | | 384 | 6 | HEB | | |
| 19 | 220 | 1135 | 646 | | 1781 | 170 | 2151 | 90 | 548980 | 3.0 | 220 | 13000 | 7.4 | 7.5 | | 422 | 421 | | 385 | 6 | HEB | | |
| 20 | 220 | 1185 | 627 | | 1815 | 138 | 1938 | 90 | 585220 | 3.0 | 220 | 18240 | 7.4 | 7.5 | | 422 | 421 | | 385 | 6 | HEB | | |
| 21 | 220 | 963 | 864 | | 1827 | 169 | 1360 | 90 | 742320 | 3.0 | 220 | 10880 | 7.4 | 7.4 | | 422 | 422 | | 384 | 6 | FW | | |
| 22 | 220 | 1172 | 507 | | 1679 | 174 | 1450 | 90 | 386900 | 3.0 | 220 | 11320 | 7.4 | 7.5 | | 422 | 421 | | 384 | 6 | 7U | | |
| 23 | 220 | 1231 | 609 | | 1840 | 143 | 1567 | 91 | 481090 | 3.4 | 224 | 7670 | 7.4 | 7.5 | | 422 | 421 | | 384 | 6 | HEB | | |
| 24 | 220 | 1167 | 654 | | 1821 | 139 | 1305 | 93 | 514850 | 3.2 | 223 | 9840 | 7.4 | 7.5 | | 422 | 421 | | 385 | 6 | HEB | | |
| 25 | 220 | 1051 | 731 | | 1782 | 133 | 640 | 90 | 584900 | 3.3 | 223 | 8500 | 7.4 | 7.5 | | 422 | 421 | | 383 | 6 | HEB | | |
| 26 | 220 | 1173 | 646 | | 1818 | 148 | 100 | 87 | 493110 | 3.2 | 222 | 9750 | 7.4 | 7.5 | | 422 | 421 | | 384 | 6 | HEB | | |
| 27 | 220 | 1202 | 626 | | 1828 | 164 | 100 | 86 | 491790 | 3.1 | 221 | 10090 | 7.4 | 7.5 | | 422 | 422 | | 383 | 6 | HEC | | |
| 28 | 220 | 1271 | 597 | | 1868 | 173 | 100 | 86 | 461330 | 3.1 | 221 | 10370 | 7.4 | 7.5 | | 422 | 421 | | 383 | 6 | W | | |
| 29 | 220 | 1260 | 606 | | 1866 | 172 | 100 | 86 | 450400 | 3.0 | 220 | 11650 | 7.4 | 7.5 | | 422 | 421 | | 383 | 6 | 7U | | |
| 30 | 220 | 1285 | 575 | | 1860 | 175 | 100 | 88 | 452400 | 3.1 | 221 | 10470 | 7.4 | 7.5 | | 422 | 421 | | 383 | 6 | HEB | | |
| 31 | 220 | 1322 | 555 | | 1874 | 180 | 100 | 84 | 430130 | 3.2 | 222 | 9510 | 7.4 | 7.5 | | 422 | 421 | | 384 | 6 | HEB | | |
| TOTAL | 6820 | 32309 | 21680 | | 53989 | 5415 | 16256 | 2730 | 17527320 | 94.7 | 6838 | 388100 | 229.7 | 231.0 | | 13079 | 13066 | | 11886 | 186 | | | |
| MAXIMUM | 220 | 1323 | 830 | | 1874 | 181 | 2151 | 92 | 742320 | 3.4 | 224 | 16000 | 7.5 | 7.5 | | 422 | 422 | | 385 | 6 | | | |
| MINIMUM | 220 | 742 | 541 | | 1548 | 100 | 100 | 80 | 102780 | 3.0 | 220 | 7630 | 7.4 | 7.4 | | 421 | 421 | | 382 | 6 | | | |
| AVERAGE | 220 | 1042 | 699 | | 1742 | 175 | 524 | 88 | 565397 | 3.05 | 220.6 | 12519 | 7.41 | 7.45 | | 421.9 | 421.5 | | 383 | 6 | | | |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

WOOD: 1949.4, OIL: 90.13, NAT. GAS: ~~7228.26~~ 7228.81

REMARKS: 480

* Reclaimed [illegible] S.: 15,013 GL., NO.2 OIL: 1,233

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: Wayne L. Bowman

DATE: 9 Aug 93

APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3007

A.5-92

**FACILITIES ENGINEERING OPERATING LOG** *(Boiler Plant)*

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CENTRAL ENERGY PLANT | BLDG. NO. 1412 | MONTH: JUNE 1993

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 4 1,000 LB. (2) | BOILER 2 1,000 LB. (3) | BOILER 3 1,000 LB. (4) | TOTAL 1,000 LB. (5) | WOOD TONS 2,000 LB. (6) | OIL FUEL USED GAL. * (7) | NAT. GAS CF (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. (10) | TEMP. °F. (11) | MAKEUP GAL. (12) | %CO2 BOILER 4 (13) | 2 (14) | 3 (15) | FLUE GAS TEMPERATURE BOILER 4 °F. (16) | 2 °F. (17) | 3 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | (22) | (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 220 | 996 | | 722 | 1698 | 71 | 1518 | 818360 | 82 | 3.2 | 223 | 8000 | 7.5 | 7.4 | 7.4 | 421 | 422 | 422 | 373 | 6 | WB | | |
| 2 | 220 | 660 | | 894 | 1554 | 71 | 1120 | 882790 | 81 | 3.2 | 223 | 8610 | 7.6 | 7.4 | 7.4 | 420 | 422 | 422 | 373 | 6 | DR | | |
| 3 | 220 | 1152 | | 681 | 1833 | 68 | 1555 | 701220 | 81 | 3.3 | 224 | 7730 | 7.4 | 7.4 | 7.4 | 422 | 422 | 422 | 373 | 6 | ER | | |
| 4 | 220 | 1201 | 652 | | 1853 | 67 | 1665 | 653343 | 84 | 3.2 | 223 | 8560 | 7.4 | | 7.4 | 422 | | 422 | 374 | 6 | RLH | | |
| 5 | 220 | 1059 | 783 | | 1842 | 71 | 684 | 741570 | 86 | 3.3 | 224 | 7610 | 7.5 | | 7.4 | 421 | | 422 | 375 | 6 | WB | | |
| 6 | 220 | 959 | 778 | | 1737 | 72 | 600 | 611750 | 83 | 3.3 | 224 | 7600 | 7.5 | | 7.4 | 421 | | 422 | 374 | 6 | WB | | |
| 7 | 220 | 952 | 816 | | 1768 | 70 | 600 | 678480 | 83 | 3.1 | 222 | [illegible] | 7.5 | | 7.4 | 421 | | 422 | [illegible] | 6 | [illegible] | | |
| 8 | 220 | 1002 | 746 | | 1748 | [illegible] | 600 | 636850 | 89 | 3.1 | 222 | 10600 | 7.4 | | 7.4 | 422 | | 422 | 376 | 6 | MW | | |
| 9 | 220 | 977 | 784 | | 1755 | [illegible] | 550 | 639980 | 93 | 3.2 | 223 | 8590 | 7.5 | | 7.4 | 421 | | 422 | [illegible] | 6 | [illegible] | | |
| 10 | 220 | 1013 | 716 | | 1729 | 100 | 550 | 578030 | 89 | 3.2 | 223 | 9200 | 7.4 | | 7.4 | 422 | | 422 | [illegible] | [illegible] | ELB | | |
| 11 | 220 | 1025 | 715 | | 1740 | 91 | 600 | 559660 | 89 | 3.2 | 223 | 8860 | 7.4 | | 7.4 | 422 | | 422 | [illegible] | 6 | [illegible] | | |
| 12 | 220 | 999 | 749 | | 1748 | 100 | 400 | 582570 | 84 | 3.2 | 223 | 9080 | 7.5 | | 7.4 | 421 | | 422 | 374 | 6 | MW | | |
| 13 | 220 | 938 | 750 | 60 | 1748 | 79 | 300 | 619390 | 81 | 3.3 | 224 | 7880 | 7.5 | 7.6 | 7.4 | 421 | 420 | 422 | 374 | 6 | WB | | |
| 14 | 220 | 821 | 590 | 291 | 1702 | 77 | 0 | 546280 | 76 | 3.0 | 220 | 11640 | 7.5 | 7.6 | 7.5 | 421 | 420 | 421 | 373 | 6 | MW | | |
| 15 | 220 | 983 | 691 | | 1674 | 65 | 100 | 573650 | 77 | 3.3 | 224 | 7560 | 7.5 | | 7.4 | 421 | | 422 | 373 | 6 | WB | | |
| 16 | 220 | 1043 | 670 | | 1713 | 74 | 100 | 55000 | 78 | 3.1 | 221 | 10910 | 7.4 | | 7.4 | 422 | | 422 | 374 | 6 | ELB | | |
| 17 | 220 | 939 | 712 | | 1651 | 66 | 200 | 55000 | 77 | 3.1 | 221 | 10850 | 7.5 | | 7.4 | 421 | | 422 | 373 | 6 | BR | | |
| 18 | 220 | 942 | 684 | | 1626 | 77 | 150 | 528270 | 77 | 3.2 | 222 | 9320 | 7.5 | | 7.4 | 421 | | 422 | 373 | 6 | WB | | |
| 19 | 220 | 890 | 826 | | 1652 | 63 | 200 | 532150 | 76 | 3.2 | 222 | 9350 | 7.5 | | 7.4 | 421 | | 422 | 373 | 6 | WB | | |
| 20 | 220 | 817 | 762 | | 1579 | 69 | 200 | 676250 | 79 | 3.2 | 223 | 8700 | 7.5 | | 7.4 | 421 | | 422 | 374 | 6 | AHW | | |
| 21 | 220 | 869 | 799 | | 1668 | 70 | 200 | 684190 | 84 | 3.1 | 221 | 10800 | 7.5 | | 7.4 | 421 | | 422 | 374 | 6 | WB | | |
| 22 | 220 | 921 | 814 | | 1735 | 63 | 200 | 664690 | 84 | 3.0 | 220 | 19040 | 7.5 | | 7.4 | 421 | | 422 | 374 | 6 | MW | | |
| 23 | 220 | 925 | 804 | | 1729 | 67 | 200 | 645740 | 87 | 3.0 | 220 | 12100 | 7.5 | | 7.4 | 421 | | 422 | 376 | 6 | ELB | | |
| 24 | 220 | 907 | 774 | | 1681 | 72 | 190 | 642360 | 78 | 3.1 | 222 | 9790 | 7.5 | | 7.4 | 421 | | 422 | [illegible] | [illegible] | DR | | |
| 25 | 220 | 956 | 806 | | 1762 | 60 | 100 | 716850 | [illegible] | 3.0 | 220 | 12310 | 7.5 | | 7.4 | 421 | | 422 | [illegible] | 6 | JH | | |
| 26 | 220 | 877 | 778 | | 1655 | 69 | 100 | 624540 | 85 | 3.0 | 220 | 11990 | 7.5 | | 7.4 | 421 | | 422 | 375 | 6 | HEB | | |
| 27 | 220 | 910 | 765 | | 1675 | 64 | 100 | 582930 | 85 | 3.0 | 220 | 12960 | 7.5 | | 7.4 | 421 | | 422 | [illegible] | [illegible] | HEB | | |
| 28 | 220 | 917 | 762 | | 1679 | 65 | 100 | 594580 | 87 | 3.0 | 220 | 13050 | 7.5 | | 7.4 | 421 | | 422 | 376 | 6 | HEB | | |
| 29 | 220 | 912 | 756 | | 1668 | 64 | 100 | 591770 | 86 | 3.0 | 220 | 14700 | 7.5 | | 7.4 | 421 | | 422 | 376 | 6 | HEB | | |
| 30 | 220 | 934 | 754 | | 1688 | 65 | 200 | 628170 | 84 | 3.0 | 220 | 14900 | 7.5 | | 7.4 | 421 | | 422 | 375 | 6 | FW | | |
| 31 | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | 6600 | [illegible] | 20236 | 2648 | 53228 | 2200 | 13182 | 19181660 | 2487 | 94.1 | 6657 | 301180 | 224.5 | 37.4 | 222.1 | 1264 | 2106 | 1266 | 11231 | 180 | | | |
| MAXIMUM | 220 | 1152 | 826 | 894 | 1853 | 100 | 1665 | 882790 | 93 | 3.3 | 224 | 19070 | 7.6 | 7.6 | 7.5 | 422 | 422 | 422 | 377 | 6 | | | |
| MINIMUM | 220 | 660 | 590 | 60 | 1554 | 60 | 100 | 528270 | 76 | 3.0 | 220 | 7600 | 7.4 | 7.4 | 7.4 | 421 | 420 | 421 | 373 | 6 | | | |
| AVERAGE | 220 | 951 | 749 | 529 | 1774 | 73 | 454 | 636055 | 82 | 3.14 | 222 | 10039 | 7.5 | 7.5 | 7.4 | 421 | 421 | 422 | 374 | 6 | | | |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 792, OIL: 73.13, NAT. GAS: 374.54

REMARKS: 312260 * RECLAIMED OIL F.S.: 6128 GL., NO. 2 OIL: 7054

PREPARED BY: [signature] | DATE: 4 Jul 93 | APPROVED BY: | DATE: | POST ENGINEER: | DATE:

SEE REVERSE SIDE FOR INSTRUCTIONS

A.5-93

# FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is the Corps of Engineers.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313
PLANT: CENTRAL ENERGY PLANT
BLDG. NO.: 1412
MONTH: MAY 1993

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 1 1,000 LB. (2) | BOILER 2 1,000 LB. (3) | BOILER 4 1,000 LB. (4) | TOTAL 1,000 LB. (5) | WOOD TONS (6) | OIL GAL. * (7) | NAT. GAS C(8)F | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. (10) | FEEDWATER HEATER TEMP. °F. (11) | FEEDWATER HEATER MAKEUP GAL. (12) | % CO2 BOILER 1 (13) | % CO2 BOILER 2 (14) | % CO2 BOILER 4 (15) | FLUE GAS TEMPERATURE BOILER 1 °F. (16) | FLUE GAS TEMPERATURE BOILER 2 °F. (17) | FLUE GAS TEMPERATURE BOILER 4 °F. (18) | TEMP. H. W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | (22) | (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 220 | | | 1401 | 1401 | 183 | 520 | 8620 | 70 | 3.0 | 220 | 13080 | | | 7.4 | | | 422 | 370 | 6 | ZU | | |
| 2 | 220 | | | 1396 | 1396 | 183 | 420 | 13820 | 73 | 3.0 | 220 | 14716 | | | 7.4 | | | 422 | 371 | 6 | FW | | |
| 3 | 220 | | | 1437 | 1437 | 198 | 490 | 7490 | 66 | 3.0 | 220 | 14360 | | | 7.4 | | | 422 | 370 | 6 | ZU | | |
| 4 | 220 | | | 1375 | 1375 | 181 | 440 | 16700 | 71 | 3.2 | 223 | 9040 | | | 7.4 | | | 422 | 370 | 6 | AR | | |
| 5 | 220 | | | 1402 | 1402 | 190 | 160 | 3900 | 78 | 3.2 | 223 | 8880 | | | 7.4 | | | 422 | 372 | 6 | ELB | | |
| 6 | 220 | 20 | | 1364 | 1384 | 176 | 680 | 25710 | 77 | 3.1 | 222 | 9600 | 7.6 | | 7.4 | 420 | | 422 | 372 | 6 | PL | | |
| 7 | 220 | 151 | | 1492 | 1643 | 191 | 820 | 74500 | 76 | 3.2 | 223 | 8560 | 7.6 | | 7.4 | 420 | | 422 | 372 | 6 | ZW | | |
| 8 | 220 | 48 | | 2162 | 2210 | 270 | 1614 | 17495 | 71 | 3.2 | 223 | 8050 | 7.6 | | 7.4 | 420 | | 422 | 370 | 6 | FW | | |
| 9 | 220 | | | 2067 | 2067 | 155 | 1762 | 14470 | 70 | 3.0 | 220 | 11850 | | | 7.4 | | | 422 | 370 | 6 | ZU | | |
| 10 | 220 | | | 1951 | 1951 | 140 | 1708 | 14510 | 72 | 3.0 | 220 | 14050 | | | 7.4 | | | 422 | 370 | 6 | FW | | |
| 11 | 220 | | 400 | 1588 | 1983 | 138 | 2055 | 25700 | 72 | 3.3 | 224 | 8020 | | 7.5 | 7.4 | | 421 | 422 | 370 | 6 | ZU | | |
| 12 | 220 | 1253 | | 785 | 2038 | 94 | 864 | 1058870 | 77 | 3.3 | 224 | 7630 | 7.4 | | 7.4 | 422 | | 422 | 373 | 6 | ELB | | |
| 13 | 220 | 1831 | | 113 | 1944 | 9 | 370 | 1721150 | 74 | 3.4 | 225 | 5300 | 7.4 | | 7.6 | 422 | | 420 | 372 | 6 | ELB | | |
| 14 | 220 | | | 1970 | 1970 | 138 | 800 | 4600 | 72 | 3.3 | 224 | 7960 | | | 7.4 | | | 422 | 370 | 6 | ZU | | |
| 15 | 220 | | | 1814 | 1814 | 128 | 100 | 14070 | 76 | 3.4 | 225 | 6090 | | | 7.4 | | | 422 | 372 | 6 | MW | | |
| 16 | 220 | | 68 | 1739 | 1807 | 140 | 1210 | | 76 | 3.3 | 224 | 6580 | | | 7.4 | | | 422 | 372 | 6 | WB | | |
| 17 | 220 | | 701 | 1239 | 1940 | 149 | 2130 | 522180 | 79 | 3.3 | 224 | 6750 | | 7.5 | 7.5 | | 421 | 421 | 373 | 6 | MW | | |
| 18 | 220 | | 555 | 1346 | 1901 | 186 | 1590 | 560570 | 81 | 3.4 | 225 | 3880 | | 7.5 | 7.4 | | 421 | 422 | 374 | 6 | WB | | |
| 19 | 220 | | 60 | 1924 | 1984 | 118 | 1340 | 118690 | 76 | 3.2 | 223 | 8330 | | 7.6 | 7.4 | | 420 | 422 | 372 | 6 | AR | | |
| 20 | 220 | | | 1985 | 1905 | 101 | 450 | 24350 | 76 | 3.3 | 224 | 6890 | | | 7.4 | | | 422 | 372 | 6 | ELB | | |
| 21 | 220 | | | 1808 | 1808 | 143 | 120 | 20080 | 66 | 3.1 | 221 | 10360 | | | 7.4 | | | 422 | 370 | 6 | MW | | |
| 22 | 220 | | | 1769 | 1769 | 134 | 520 | 24590 | 65 | 3.3 | 224 | 7540 | | | 7.4 | | | 422 | 370 | 6 | WB | | |
| 23 | 220 | | | 1759 | 1759 | 232 | 540 | 31900 | 67 | 3.3 | 224 | 6950 | | | 7.4 | | | 422 | 370 | 6 | MW | | |
| 24 | 220 | | | 1791 | 1791 | 212 | 920 | 26510 | 73 | 3.4 | 224 | 5900 | | | 7.4 | | | 422 | 370 | 6 | WB | | |
| 25 | 220 | | 177 | 1536 | 1713 | 201 | 600 | 246660 | 72 | 3.4 | 224 | 6390 | | 7.6 | 7.9 | | 420 | 422 | 370 | 6 | MW | | |
| 26 | 220 | | 552 | 559 | 1111 | 77 | 500 | 802470 | 73 | 3.4 | 225 | 4980 | | 7.5 | 7.5 | | 421 | 421 | 370 | 6 | AR | | |
| 27 | 220 | | 323 | 1062 | 1386 | 138 | 500 | 785890 | 74 | 3.2 | 223 | 8180 | | 7.6 | 7.5 | | 420 | 421 | 371 | 6 | ELB | | |
| 28 | 220 | | 717 | 962 | 1679 | 132 | 500 | 761900 | 73 | 3.4 | 224 | 7010 | | 7.5 | 7.5 | | 421 | 421 | 371 | 6 | WB | | |
| 29 | 220 | | 722 | 1020 | 1742 | 130 | 600 | 745860 | 77 | 3.2 | 223 | 9110 | | 7.5 | 7.5 | | 421 | 421 | 372 | 6 | MW | | |
| 30 | 220 | | 704 | 1036 | 1740 | 100 | 2507 | 765960 | 78 | 3.4 | 225 | 5570 | | 7.5 | 7.5 | | 421 | 421 | 372 | 6 | WB | | |
| 31 | 220 | | 714 | 991 | 1705 | 107 | 1755 | 781490 | 78 | 3.3 | 224 | 7830 | | 7.5 | 7.5 | | 421 | 421 | 372 | 6 | MW | | |
| TOTAL | 6820 | 5117 | 4976 | 44758 | 54851 | 4674 | 28583 | 6812697 | 2278 | 100.4 | 6917 | 258830 | 37.6 | 82.8 | 230.3 | 2104 | 4628 | 13066 | 11505 | 186 | | | |
| MAXIMUM | 220 | 1831 | 722 | 2162 | 2210 | 232 | 2507 | 802470 | 81 | 3.4 | 225 | 14710 | 7.6 | 7.6 | 7.6 | 422 | 421 | 422 | 374 | 6 | | | |
| MINIMUM | 220 | 20 | 60 | 113 | 1375 | 9 | 100 | 4600 | 65 | 3.0 | 220 | 4980 | 7.4 | 7.5 | 7.4 | 420 | 420 | 420 | 370 | 6 | | | |
| AVERAGE | 220 | 852 | 414 | 1443 | 1769 | 150 | 922 | 219764 | 73 | 3.2 | 223 | 8349 | 7.5 | 7.5 | 7.43 | 421 | 420.7 | 421 | 371 | 6 | | | |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 1682.64, OIL: 158.58 NAT. GAS: 280.97

REMARKS: * RECLAIMED OIL F.S.: 12,265, NO. 2 OIL: 16318

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: [signature] DATE: 7 Jun 93

APPROVED BY: [signature] DATE: 8 Jun 93

POST ENGINEER: DAVID A. FAGAN, LTC, EN, DEH DATE: 6/8/93

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 5-98, 1 JUN 50, WHICH WILL BE USED.

A.5-94

# FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

| INSTALLATION | PLANT | BLDG. NO. | MONTH |
|---|---|---|---|
| HEADQUARTERS FORT STEWART<br>FORT STEWART, GEORGIA 31313 | CENTRAL ENERGY PLANT | 1412 | APR 1993 |

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 1 1,000 LB. (2) | BOILER 4 1,000 LB. (3) | BOILER 3 1,000 LB. (4) | TOTAL 1,000 LB. (5) | WOOD TONS (6) | OIL * FUEL USED (7) | NAT. GAS CF (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. (10) | FEEDWATER HEATER TEMP. °F. (11) | MAKEUP GAL. (12) | %CO2 BOILER 1 (13) | %CO2 BOILER 4 (14) | %CO2 BOILER 3 (15) | FLUE GAS TEMP. BOILER 1 °F. (16) | FLUE GAS TEMP. BOILER 4 °F. (17) | FLUE GAS TEMP. BOILER 3 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | (22) | (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 220 | | 1534 | | 1534 | 112 | 2355 | 40960 | 69 | 3.0 | 220 | 11210 | | 7.4 | | | 422 | | 370 | 6 | HEB | | |
| 2 | 220 | | 1689 | | 1689 | 135 | 2260 | 27080 | 55 | 3.1 | 221 | 10680 | | 7.4 | | | 422 | | 370 | 6 | DR | | |
| 3 | 220 | | 1828 | | 1828 | 157 | 2118 | 28960 | 52 | 3.0 | 220 | 12500 | | 7.4 | | | 422 | | 370 | 6 | 74 | | |
| 4 | 220 | | 1710 | | 1710 | 141 | 2082 | 7280 | 57 | 3.1 | 221 | 9920 | | 7.4 | | | 422 | | 370 | 6 | FW | | |
| 5 | 220 | | 1760 | | 1760 | 165 | 1122 | 17720 | 61 | 3.0 | 220 | 13090 | | 7.4 | | | 422 | | 370 | 6 | 74 | | |
| 6 | 220 | | 1908 | | 1908 | 202 | 700 | 14280 | 57 | 3.0 | 220 | 13340 | | 7.4 | | | 422 | | 370 | 6 | FW | | |
| 7 | 220 | | 1820 | | 1820 | 185 | 340 | 16500 | 57 | 3.2 | 223 | 8140 | | 7.4 | | | 422 | | 370 | 6 | [illegible] | | |
| 8 | 220 | | 1798 | | 1798 | 180 | 490 | 14450 | 58 | 3.1 | 221 | 10130 | | 7.4 | | | 422 | | 370 | 6 | QTH | | |
| 9 | 220 | | 1737 | | 1737 | 166 | 790 | 15600 | 64 | 3.0 | 220 | 12190 | | 7.4 | | | 422 | | 370 | 6 | 74 | | |
| 10 | 220 | | 1702 | | 1702 | 169 | 330 | 11260 | 62 | 3.0 | 220 | 12720 | | 7.4 | | | 422 | | 370 | 6 | FW | | |
| 11 | 220 | 56 | 1546 | 50 | 1652 | 142 | 630 | 77500 | 65 | 3.0 | 220 | 12030 | 7.6 | 7.4 | 7.6 | 420 | 422 | 420 | 370 | 6 | 74 | | |
| 12 | 220 | | 1642 | | 1642 | 163 | 1180 | 12520 | 74 | 3.0 | 220 | 14470 | | 7.4 | | | 422 | | 371 | 6 | FW | | |
| 13 | 220 | | 1604 | | 1604 | 155 | 900 | 10448 | 70 | 3.0 | 220 | 14950 | | 7.4 | | | 422 | | 370 | 6 | 74 | | |
| 14 | 220 | 45 | 1318 | 85 | 1448 | 123 | 840 | 126300 | 74 | 3.1 | 221 | 10090 | 7.6 | 7.4 | 7.6 | 420 | 422 | 420 | 371 | 6 | ELB | | |
| 15 | 220 | | 1578 | | 1578 | 141 | 1008 | 7080 | 72 | 3.0 | 220 | 13890 | | 7.4 | | | 422 | | 371 | 6 | PL | | |
| 16 | 220 | | 1448 | | 1448 | 106 | 2000 | 8130 | 68 | 3.0 | 220 | 13901 | | 7.4 | | | 422 | | 370 | 6 | 7W | | |
| 17 | 220 | | 1460 | | 1460 | 113 | 1730 | 17150 | 60 | 3.0 | 220 | 15350 | | 7.4 | | | 422 | | 376 | 6 | 74 | | |
| 18 | 220 | | 1475 | | 1475 | 124 | 1161 | 7450 | 59 | 3.0 | 220 | 13760 | | 7.4 | | | 422 | | 370 | 6 | FW | | |
| 19 | 220 | | 1481 | | 1481 | 128 | 994 | 15110 | 63 | 3.0 | 220 | 16130 | | 7.4 | | | 422 | | 370 | 6 | 74 | | |
| 20 | 220 | | 1282 | 118 | 1400 | 92 | 1472 | 174936 | 67 | 3.0 | 220 | 15670 | | 7.4 | 7.6 | | 422 | 420 | 370 | 6 | FW | | |
| 21 | 220 | | 1446 | | 1446 | 105 | 2052 | 14170 | 66 | 3.0 | 220 | 15070 | | 7.4 | | | 422 | | 370 | 6 | QTH | | |
| 22 | 220 | 50 | 1440 | | 1490 | 112 | 1490 | 161530 | 54 | 3.0 | 220 | 12290 | 7.6 | 7.4 | | 420 | 422 | | 370 | | [illegible] | | |
| 23 | 220 | | 1517 | | 1517 | 150 | 360 | 10310 | 57 | 3.0 | 220 | 25710 | | 7.4 | | | 422 | | 370 | 6 | 74 | | |
| 24 | 220 | | 1456 | | 1456 | 141 | 560 | 8080 | 65 | 3.0 | 220 | 17530 | | 7.4 | | | 422 | | 370 | 6 | FW | | |
| 25 | 220 | | 1445 | | 1445 | 133 | 370 | 19520 | 68 | 3.0 | 220 | 18320 | | 7.4 | | | 422 | | 370 | 6 | 74 | | |
| 26 | 220 | | 1280 | 245 | 1525 | 113 | 250 | 157590 | 67 | 3.0 | 220 | 18150 | | 7.4 | 7.6 | | 422 | 420 | 370 | 6 | FW | | |
| 27 | 220 | | 1398 | | 1398 | 131 | 1130 | 29184 | 60 | 3.0 | 220 | 21060 | | 7.4 | | | 422 | | 370 | 6 | 74 | | |
| 28 | 220 | | 1472 | | 1472 | 132 | 230 | 10520 | 59 | 3.0 | 220 | 16190 | | 7.4 | | | 422 | | 370 | 6 | PL | | |
| 29 | 220 | | 1438 | | 1438 | 134 | 290 | 11630 | 54 | 3.0 | 220 | 12800 | | 7.4 | | | 422 | | 370 | 6 | QTH | | |
| 30 | 220 | | 1417 | | 1417 | 133 | 911 | 12900 | 64 | 3.0 | 220 | 14530 | | 7.4 | | | 422 | | 370 | | FW | | |
| 31 | | | | | | | | | | | | 7830 | | | | | | | | | | | |
| TOTAL | 6600 | 151 | 46627 | 498 | 47278 | 4169 | 32017 | 1085944 | 1878 | 90.7 | 6607 | 425981 | 22.8 | 222.0 | 30.4 | 1260 | 12660 | 1280 | 11103 | 180 | | | |
| MAXIMUM | 220 | 56 | 1908 | 245 | 1908 | 202 | 2355 | 174936 | 74 | 3.3 | 223 | 25710 | 7.6 | 7.4 | 7.6 | 420 | 422 | 420 | 371 | 6 | | | |
| MINIMUM | 220 | 45 | 1280 | 50 | 1398 | 92 | 230 | 7080 | 52 | 3.0 | 220 | 8140 | 7.6 | 7.4 | 7.6 | 420 | 422 | 420 | 370 | 6 | | | |
| AVERAGE | 220 | 50 | 1554 | 125 | 1576 | 139 | 1067 | 36198 | 63 | 3.02 | 220.2 | 14193 | 7.6 | 7.4 | 7.6 | 420 | 422 | 420 | 370.1 | 6 | | | |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 1500.84, OIL: 177.63, NAT. GAS: 44.74

REMARKS: * RECLAIMED OIL FROM F.S. = 20106, NO. 2 OIL = 11911

SEE REVERSE SIDE FOR INSTRUCTIONS

| PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE |
|---|---|---|---|---|---|
| Wayne L. B[illegible] | 8 MAY 1993 | | | | |

A.5-95

A.5-96

**FACILITIES ENGINEERING OPERATING LOG** *(Boiler Plant)*
For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313
PLANT: CENTRAL ENERGY PLANT
BLDG. NO.: 1412
MONTH: MAR 1993

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 1 1,000 LB. (2) | STEAM PRODUCED BOILER 4 1,000 LB. (3) | STEAM PRODUCED BOILER 3 1,000 LB. (4) | STEAM PRODUCED TOTAL 1,000 LB. (5) | WOOD TONS 2,000 LB. (6) | OIL FUEL USED GAL. (7) | NAT. GAS CU FT (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. (10) | FEEDWATER HEATER TEMP. °F. (11) | FEEDWATER HEATER MAKEUP GAL. (12) | %CO2 BOILER 1 (13) | %CO2 BOILER 4 (14) | %CO2 BOILER 3 (15) | FLUE GAS TEMP. BOILER 1 °F. (16) | FLUE GAS TEMP. BOILER 4 °F. (17) | FLUE GAS TEMP. BOILER 3 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | (22) | (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 220 | 125 | 1659 | | 1784 | 206 | 1168 | 11490 | 47 | 3.0 | 220 | 18040 | 7.6 | 7.4 | | 420 | 422 | | 370 | 6 | ELB | | |
| 2 | 220 | 120 | 430 | 1000 | 1630 | 51 | 483 | 726330 | 49 | 3.0 | 220 | 16740 | 7.6 | 7.6 | 7.4 | 420 | 420 | 422 | 370 | 6 | FU | | |
| 3 | 220 | 900 | | 615 | 1515 | | 987 | 919020 | 58 | 3.0 | 220 | 14370 | 7.4 | | 7.5 | 422 | | 421 | 370 | 6 | [illegible] | | |
| 4 | 220 | 800 | 80 | 660 | 1540 | 11 | 150 | 892450 | 56 | 3.0 | 220 | 16950 | 7.4 | 7.6 | 7.5 | 422 | 420 | 421 | 370 | 6 | HEB | | |
| 5 | 220 | 71 | 1683 | | 1754 | 211 | 1100 | 52390 | 51 | 3.0 | 220 | 16710 | 7.6 | 7.4 | | 420 | 422 | | 370 | 6 | ELB | | |
| 6 | 220 | | 1730 | | 1730 | 227 | 2012 | 10020 | 50 | 3.0 | 220 | 14800 | | 7.4 | | | 422 | | 370 | 6 | DR | | |
| 7 | 220 | | 1707 | | 1707 | 213 | 667 | 6350 | 53 | 3.0 | 220 | 18500 | | 7.4 | | | 422 | | 370 | 6 | ELB | | |
| 8 | 220 | | 1552 | | 1552 | 199 | 807 | 12960 | 59 | 3.0 | 220 | 21990 | | 7.4 | | | 422 | | 370 | 6 | DR | | |
| 9 | 220 | 47 | 1327 | | 1374 | 181 | 436 | 35080 | 63 | 3.0 | 220 | 18800 | 7.6 | 7.4 | | 420 | 422 | | 370 | 6 | ELB | | |
| 10 | 220 | 170 | 1368 | | 1538 | 188 | 360 | 108780 | 68 | 3.0 | 220 | 18830 | 7.6 | 7.4 | | 420 | 422 | | 370 | 6 | HEB | | |
| 11 | 220 | 106 | 1415 | | 1521 | 194 | 490 | 72530 | 60 | 3.0 | 220 | 14170 | 7.6 | 7.4 | | 420 | 422 | | 370 | 6 | HEB | | |
| 12 | 220 | | 1780 | | 1780 | 130 | 400 | 9360 | 56 | 3.0 | 220 | 11060 | | 7.4 | | | 422 | | 370 | 6 | DR | | |
| 13 | 220 | 557 | 874 | | 1431 | 120 | 200 | 448960 | 46 | 3.0 | 220 | 13390 | 7.5 | 7.5 | | 421 | 421 | | 370 | 6 | ELB | | |
| 14 | 220 | | 1984 | | 1984 | 158 | 440 | 100 | 34 | 3.4 | 224 | 6120 | | 7.4 | | | 422 | | 370 | 6 | DR | | |
| 15 | 220 | | 2028 | | 2028 | 163 | 460 | 8080 | 36 | 3.2 | 223 | 9890 | | 7.4 | | | 422 | | 370 | 6 | ELB | | |
| 16 | 220 | | 1916 | | 1916 | 155 | 470 | 16190 | 47 | 3.2 | 223 | 9730 | | 7.4 | | | 422 | | 370 | 6 | DR | | |
| 17 | 220 | | 1648 | | 1648 | 222 | 270 | 3159 | 57 | 3.4 | 224 | 1001 | | 7.4 | | | 422 | | 370 | 6 | HEB | | |
| 18 | 220 | | 1717 | | 1717 | 230 | 552 | 21901 | 49 | 3.4 | 224 | 1095 | | 7.4 | | | 422 | | 370 | 6 | HEB | | |
| 19 | 220 | | 1842 | | 1842 | 231 | 1359 | 43860 | 42 | 3.3 | 223 | 5530 | | 7.4 | | | 422 | | 370 | 6 | ELB | | |
| 20 | 220 | | 1440 | | 1440 | 180 | 1051 | 113640 | 50 | 3.1 | 221 | 9830 | | 7.4 | | | 422 | | 370 | 6 | DR | | |
| 21 | 220 | | 1605 | | 1605 | 200 | 1217 | 8210 | 58 | 3.0 | 220 | 12150 | | 7.4 | | | 422 | | 370 | 6 | ELB | | |
| 22 | 220 | | 1737 | | 1737 | 204 | 2112 | 2200 | 62 | 3.0 | 220 | 14630 | | 7.4 | | | 422 | | 370 | 6 | DR | | |
| 23 | 220 | | 1702 | | 1702 | 211 | 1427 | 25780 | 64 | 3.0 | 220 | 13280 | | 7.4 | | | 422 | | 370 | 6 | ELB | | |
| 24 | 220 | | 1689 | | 1689 | 128 | 170 | 7300 | 66 | 3.2 | 222 | 8670 | | 7.4 | | | 422 | | 370 | 6 | WRH | | |
| 25 | 220 | | 1687 | | 1687 | 124 | 470 | 16160 | 72 | 3.1 | 221 | 10170 | | 7.4 | | | 422 | | 370 | 6 | [illegible] | | |
| 26 | 220 | | 1761 | | 1761 | 133 | 500 | 11480 | 56 | 3.0 | 220 | 12720 | | 7.4 | | | 422 | | 370 | 6 | WRH | | |
| 27 | 220 | | 1715 | | 1715 | 130 | 300 | 22100 | 62 | 3.1 | 221 | 10550 | | 7.4 | | | 422 | | 370 | 6 | DR | | |
| 28 | 220 | | 1714 | | 1714 | 132 | 230 | 9850 | 64 | 3.2 | 222 | 9700 | | 7.4 | | | 422 | | 370 | 6 | WRH | | |
| 29 | 220 | | 1698 | | 1698 | 131 | 160 | 15300 | 65 | 3.0 | 220 | 15510 | | 7.4 | | | 422 | | 370 | 6 | DR | | |
| 30 | 220 | | 1648 | | 1648 | 223 | 220 | 13270 | 68 | 3.0 | 220 | 12660 | | 7.4 | | | 422 | | 370 | 6 | WRH | | |
| 31 | 220 | | 1629 | | 1629 | 200 | 1471 | 16850 | 64 | 3.2 | 223 | 8830 | | 7.4 | | | 422 | | 370 | 6 | HEB | | |
| TOTAL | 6820 | 2896 | 46765 | 2275 | 51936 | 5086 | 22066 | 3736050 | 1732 | 95.8 | 6851 | 386470 | 67.9 | 222.5 | 22.4 | 3785 | 12655 | 1264 | 11470 | 186 | | | |
| MAXIMUM | 220 | 900 | 2028 | 1000 | 2028 | 231 | 2112 | 919020 | 72 | 3.4 | 224 | 21990 | 7.6 | 7.6 | 7.5 | 422 | 422 | 422 | 370 | 6 | | | |
| MINIMUM | 220 | 47 | 80 | 615 | 1379 | 11 | 150 | 100 | 34 | 3.0 | 220 | 1001 | 7.4 | 7.4 | 7.4 | 420 | 420 | 421 | 370 | 6 | | | |
| AVERAGE | 220 | 322 | 1559 | 758 | 1675 | 170 | 712 | 120518 | 56 | 3.1 | 221 | 12470 | 7.54 | 7.42 | 7.47 | 420.6 | 421.8 | 421.3 | 370 | 6 | | | |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 1830.96, OIL: 122.42, NAT. GAS: 154.07

REMARKS: *Reclaimed Oil From F.S. = 15,889 Gl; No. 2 Oil 6117 gl.

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: [illegible signature]
DATE: 10 Apr 93
APPROVED BY:
DATE:
POST ENGINEER:
DATE:

A.5-97

## FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CENTRAL ENERGY PLANT

BLDG. NO.: 1412

MONTH: FEB 1993

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 1 1,000 LB. (2) | BOILER 2 1,000 LB. (3) | BOILER 3 1,000 LB. (4) | TOTAL 1,000 LB. (5) | WOOD TONS 2000 LB. (6) | OIL FUEL USED GAL. * (7) | NAT.GAS CU.FT. (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. (10) | FEEDWATER HEATER TEMP. °F. (11) | MAKEUP GAL. (12) | %CO2 BOILER 1 (13) | %CO2 BOILER 2 (14) | %CO2 BOILER 3 (15) | FLUE GAS TEMPERATURE BOILER 1 °F. (16) | BOILER 2 °F. (17) | BOILER 3 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | (22) | (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 220 | | 1697 | | 1697 | 199 | 2044 | 11010 | 54 | 3.2 | 222 | 9170 | | 7.4 | | | 422 | | 370 | 6 | QRH | | |
| 2 | 220 | | 1917 | | 1917 | 229 | 2089 | 13390 | 41 | 3.0 | 220 | 13540 | | 7.4 | | | 422 | | 370 | 6 | PL | | |
| 3 | 220 | | 1939 | | 1939 | 259 | 504 | 26380 | 42 | 3.0 | 220 | 13330 | | 7.4 | | | 422 | | 370 | 6 | EJ | | |
| 4 | 220 | | 1817 | | 1817 | 250 | | 10020 | 48 | 3.1 | 221 | 10340 | | 7.4 | | | 422 | | 370 | 6 | MW | | |
| 5 | 220 | | 1754 | | 1754 | 242 | | 7650 | 49 | 3.0 | 220 | 13000 | | 7.4 | | | 422 | | 370 | 6 | QRH | | |
| 6 | 220 | 50 | 1688 | | 1738 | 226 | | 57740 | 49 | 3.2 | 222 | 8930 | 7.6 | 7.4 | | 420 | 422 | | 370 | 6 | PL | | |
| 7 | 220 | | 1847 | | 1847 | 254 | | 12720 | 45 | 3.0 | 220 | 12480 | | 7.4 | | | 422 | | 370 | 6 | QRH | | |
| 8 | 220 | | 1898 | | 1898 | 261 | | 25230 | 45 | 3.0 | 220 | 11700 | | 7.4 | | | 422 | | 370 | 6 | PL | | |
| 9 | 220 | | 1897 | | 1897 | 261 | | 4910 | 48 | 3.0 | 220 | 11550 | | 7.4 | | | 422 | | 370 | 6 | QRH | | |
| 10 | 220 | | 1871 | | 1871 | 258 | | 9400 | 50 | 3.0 | 220 | 13350 | | 7.4 | | | 422 | | 370 | 6 | HEB | | |
| 11 | 220 | | 1723 | | 1723 | 229 | 500 | 10640 | 54 | 3.0 | 220 | 12680 | | 7.4 | | | 422 | | 370 | 6 | HEB | | |
| 12 | 220 | | 1804 | | 1804 | 223 | 1534 | 6700 | 62 | 3.0 | 220 | 13510 | | 7.4 | | | 422 | | 370 | 6 | PL | | |
| 13 | 220 | | 1960 | | 1960 | 243 | 1606 | 16690 | 50 | 3.0 | 220 | 14130 | | 7.4 | | | 422 | | 370 | 6 | QRH | | |
| 14 | 220 | | 2023 | | 2023 | 249 | 1723 | 8980 | 47 | 3.0 | 220 | 13920 | | 7.4 | | | 422 | | 370 | 6 | PL | | |
| 15 | 220 | | 2040 | | 2040 | 251 | 1803 | 9640 | 48 | 3.0 | 220 | 14040 | | 7.4 | | | 422 | | 370 | 6 | QRH | | |
| 16 | 220 | | 1875 | | 1875 | 259 | | 20680 | 58 | 3.0 | 220 | 18210 | | 7.4 | | | 422 | | 370 | 6 | PL | | |
| 17 | 220 | | 2024 | | 2024 | 280 | | 22898 | 47 | 3.0 | 220 | 16830 | | 7.4 | | | 422 | | 370 | 6 | EJ | | |
| 18 | 220 | 108 | 1960 | | 2068 | 255 | 1763 | 89112 | 40 | 3.0 | 220 | 13790 | 7.6 | 7.4 | | 420 | 422 | | 370 | 6 | MW | | |
| 19 | 220 | | 2108 | | 2108 | 260 | 1802 | 4890 | 37 | 3.0 | 220 | 16060 | | 7.4 | | | 422 | | 370 | 6 | HEB | | |
| 20 | 220 | | 1905 | | 1905 | 262 | 1180 | 11950 | 48 | 3.0 | 220 | 15080 | | 7.4 | | | 422 | | 370 | 6 | DR | | |
| 21 | 220 | | 1658 | | 1658 | 228 | | 96320 | 59 | 3.0 | 220 | 16030 | | 7.4 | | | 422 | | 370 | 6 | ELB | | |
| 22 | 220 | 30 | 1451 | | 1481 | 199 | | 27140 | 63 | 3.0 | 220 | 16000 | 7.6 | 7.4 | | 420 | 422 | | 370 | 6 | LR | | |
| 23 | 220 | | 1660 | | 1660 | 229 | | 10600 | 52 | 3.0 | 220 | 17780 | | 7.4 | | | 422 | | 370 | 6 | ELB | | |
| 24 | 220 | | 1816 | | 1816 | 250 | | 8190 | 47 | 3.0 | 220 | 18450 | | 7.4 | | | 422 | | 370 | 6 | HEB | | |
| 25 | 220 | | 1916 | | 1916 | 264 | | 11600 | 42 | 3.0 | 220 | 17890 | | 7.4 | | | 422 | | 370 | 6 | HEB | | |
| 26 | 220 | 800 | 200 | 845 | 1845 | 28 | 11472 | 9110 | 45 | 3.0 | 220 | 15120 | 7.4 | 7.6 | 7.4 | 422 | 420 | 422 | 370 | 6 | LR | | |
| 27 | 220 | | 1873 | | 1873 | 255 | | 10248 | 44 | 3.0 | 220 | 14460 | | 7.4 | | | 422 | | 370 | 6 | ELB | | |
| 28 | 220 | | 1695 | | 1695 | 233 | | 57250 | 44 | 3.0 | 220 | 16250 | | 7.4 | | | 422 | | 370 | 6 | LR | | |
| 29 | | | | | | | | | | | | | | | | | | | | | | | |
| 30 | | | | | | | | | | | | | | | | | | | | | | | |
| 31 | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | 6160 | 988 | 50016 | 845 | 51849 | 6888 | 28020 | 611070 | 1358 | 84.5 | 6165 | 400870 | 30.2 | 207.4 | 7.4 | 1682 | 11814 | 422 | 10360 | 168 | | | |
| MAXIMUM | 220 | 800 | 2108 | 845 | 2108 | 280 | 11472 | 96320 | 63 | 3.2 | 222 | 18450 | 7.6 | 7.6 | 7.4 | 422 | 422 | 422 | 370 | 6 | | | |
| MINIMUM | 220 | 30 | 1200 | 845 | 1481 | 28 | 500 | 4890 | 37 | 3.0 | 220 | 8930 | 7.4 | 7.4 | 7.4 | 420 | 420 | 422 | 370 | 6 | | | |
| AVERAGE | 220 | 247 | 1786 | 845 | 1852 | 246 | 2335 | 21824 | 49 | 3.02 | 220.2 | 14317 | 7.55 | 7.41 | 7.4 | 420.5 | 421.9 | 422 | 370 | 6 | | | |

VAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 2479.68, OIL: 155.45, NAT. GAS: 25.2

REMARKS: 400920 *= RECLAIMED OIL FROM F.S. = 16548 GL., NO.2 OIL = 11472 GL

PREPARED BY: [signature] | DATE: 3 MAR 93 | APPROVED BY: | DATE: | POST ENGINEER: | DATE:

SEE REVERSE SIDE FOR INSTRUCTIONS

A.5-98

# FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313
PLANT: CENTRAAL ENERGY PLANT
BLDG. NO.: 1412
MONTH: JAN 1993

| DATE | STEAM PRESSURE LB. (1) | STEAM PRODUCED BOILER 4 1,000 LB. (2) | BOILER 2 1,000 LB. (3) | BOILER 3 1,000 LB. (4) | TOTAL 1,000 LB. (5) | WOOD TONS 2,000 LB. (6) | OIL FUEL USED GAL. * (7) | NAT. GAS CU. FT. (8) | OUTSIDE TEMP. AV. °F. (9) | FEEDWATER HEATER PRESS. LB. (10) | FEEDWATER HEATER TEMP. °F. (11) | MAKEUP GAL. (12) | %CO2 BOILER 4 (13) | %CO2 BOILER 2 (14) | %CO2 BOILER 3 (15) | FLUE GAS TEMPERATURE BOILER 4 °F. (16) | BOILER 2 °F. (17) | BOILER 3 °F. (18) | TEMP. H.W. SUPPLY °F. (19) | TUBES CLEANED NUMBER OF TIMES (20) | PREVENT MAINT. CHECK (21) | (22) | (23) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 220 | 1305 | | | 1305 | 177 | 150 | 12010 | 61 | 3.4 | 224 | 9460 | 7.4 | | | 422 | | | 370 | 6 | HEB | | |
| 2 | 220 | 1458 | | | 1458 | 197 | 200 | 8310 | 52 | 3.1 | 221 | 10430 | 7.4 | | | 422 | | | 370 | 6 | HEB | | |
| 3 | 220 | 1539 | | | 1539 | 208 | 200 | 18080 | 51 | 3.0 | 220 | 14420 | 7.4 | | | 422 | | | 370 | 6 | ET | | |
| 4 | 220 | 1211 | 250 | | 1461 | 164 | 170 | 145060 | 59 | 3.4 | 224 | 6100 | 7.4 | 7.6 | | 422 | 420 | | 370 | 6 | HEB | | |
| 5 | 220 | 1164 | | | 1164 | 158 | 150 | 7890 | 67 | 3.1 | 221 | 9640 | 7.4 | | | 422 | | | 370 | 6 | HEB | | |
| 6 | 220 | 1179 | | | 1179 | 160 | 150 | 5926 | 66 | 3.1 | 221 | 10480 | 7.4 | | | 422 | | | 370 | 6 | FW | | |
| 7 | 220 | 1198 | 20 | 20 | 1238 | 147 | 1053 | 41540 | 60 | 3.0 | 220 | 11430 | 7.4 | 7.6 | 7.6 | 422 | 420 | 420 | 370 | 6 | FU | | |
| 8 | 220 | 1247 | | | 1247 | 143 | 1700 | 4948 | 65 | 3.0 | 220 | 11100 | 7.4 | | | 422 | | | 370 | 6 | HEB | | |
| 9 | 220 | 1281 | | | 1281 | 140 | 2190 | 5030 | 57 | 3.1 | 221 | 9920 | 7.4 | | | 422 | | | 370 | 6 | QXH | | |
| 10 | 220 | 1578 | | | 1578 | 184 | 1943 | 13390 | 47 | 3.0 | 220 | 16570 | 7.4 | | | 422 | | | 370 | 6 | QXH | | |
| 11 | 220 | 1652 | | | 1652 | 206 | 1204 | 1940 | 49 | 3.2 | 223 | 8230 | 7.4 | | | 422 | | | 370 | 6 | QXH | | |
| 12 | 220 | 1627 | | | 1627 | 220 | 200 | 11540 | 51 | 3.1 | 221 | 10850 | 7.4 | | | 422 | | | 370 | 6 | QXH | | |
| 13 | 220 | 1469 | | | 1469 | 199 | 170 | 6350 | 60 | 3.0 | 220 | 11550 | 7.4 | | | 422 | | | 370 | 6 | ET. | | |
| 14 | 220 | 1602 | | | 1602 | 217 | 200 | 540 | 50 | 3.1 | 221 | 10170 | 7.4 | | | 422 | | | 370 | 6 | MW | | |
| 15 | 220 | 1691 | | | 1691 | 229 | 210 | 10460 | 47 | 3.1 | 221 | 9770 | 7.4 | | | 422 | | | 370 | 6 | QXH | | |
| 16 | 220 | 1696 | | | 1696 | 230 | 200 | 10090 | 46 | 3.1 | 221 | 10350 | 7.4 | | | 422 | | | 370 | 6 | QXH | | |
| 17 | 220 | 1657 | | | 1657 | 225 | 200 | 12060 | 49 | 3.0 | 220 | 11180 | 7.4 | | | 422 | | | 370 | 6 | PL | | |
| 18 | 220 | 1629 | | | 1629 | 221 | 180 | 4750 | 52 | 3.1 | 221 | 9600 | 7.4 | | | 422 | | | 370 | 6 | QXH | | |
| 19 | 220 | 1646 | | | 1646 | 224 | 170 | 7980 | 51 | 3.0 | 220 | 11750 | 7.4 | | | 422 | | | 370 | 6 | QXH | | |
| 20 | 220 | 1850 | | | 1850 | 249 | 366 | 13860 | 43 | 3.0 | 220 | 11790 | 7.4 | | | 422 | | | 370 | 6 | ET | | |
| 21 | 220 | 1565 | | | 1565 | 189 | 1593 | 3150 | 59 | 3.3 | 224 | 6840 | 7.4 | | | 422 | | | 370 | 6 | MW | | |
| 22 | 220 | 917 | 250 | 193 | 1360 | 100 | 1485 | 351830 | 60 | 3.3 | 224 | 7260 | 7.4 | 7.6 | 7.6 | 422 | 420 | 420 | 370 | 6 | QXH | | |
| 23 | 220 | 1511 | | | 1511 | 184 | 1429 | 19460 | 51 | 3.0 | 220 | 11100 | 7.4 | | | 422 | | | 370 | 6 | PL | | |
| 24 | 220 | 1515 | | | 1515 | 184 | 1380 | 26380 | 57 | 3.2 | 222 | 9130 | 7.4 | | | 422 | | | 370 | 6 | QXH | | |
| 25 | 220 | 1757 | | | 1757 | 238 | 200 | 4970 | 43 | 3.1 | 221 | 10330 | 7.4 | | | 422 | | | 370 | 6 | PL | | |
| 26 | 220 | 1857 | | | 1857 | 252 | 220 | 17180 | 40 | 3.0 | 220 | 11960 | 7.4 | | | 422 | | | 370 | 6 | QXH | | |
| 27 | 220 | 1914 | | | 1914 | 260 | 180 | 13670 | 44 | 3.1 | 221 | 10470 | 7.4 | | | 422 | | | 370 | 6 | HEB | | |
| 28 | 220 | 1704 | | | 1704 | 231 | 206 | 17360 | 47 | 3.1 | 221 | 9710 | 7.4 | | | 422 | | | 370 | 6 | MW | | |
| 29 | 220 | 1603 | | | 1603 | 217 | 290 | 11510 | 52 | 3.1 | 221 | 10680 | 7.4 | | | 422 | | | 370 | 6 | PL | | |
| 30 | 220 | 1808 | | | 1808 | 211 | 2224 | 11850 | 48 | 3.0 | 220 | 11010 | 7.4 | | | 422 | | | 370 | 6 | QXH | | |
| 31 | 220 | 1807 | | | 1807 | 244 | 240 | 11740 | 46 | 3.1 | 221 | 10800 | 7.4 | | | 422 | | | 370 | 6 | PL | | |
| TOTAL | 6820 | 47637 | 520 | 213 | 48370 | 6209 | 20537 | 830399 | 1630 | 96.2 | 6855 | 324330 | 229.4 | 22.8 | 15.2 | 13082 | 1260 | | 11470 | 186 | | | |
| MAXIMUM | 220 | 1914 | 250 | 193 | 1914 | 260 | 2224 | 351830 | 67 | 3.5 | 225 | 16570 | 7.4 | 7.6 | 7.6 | 422 | 420 | | 370 | 6 | | | |
| MINIMUM | 220 | 917 | 20 | 20 | 1164 | 100 | 150 | 540 | 40 | 3.0 | 220 | 6100 | 7.4 | 7.6 | 7.6 | 422 | 420 | | 370 | 6 | | | |
| AVERAGE | 220 | 1537 | 173 | 107 | 1560 | 200 | 662 | 26786 | 53 | 3.1 | 221 | 10462 | 7.4 | 7.6 | 7.6 | 422 | 420 | | 370 | 6 | | | |

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 2235.24, OIL: 115.37, NAT. GAS: 34.24

REMARKS: 324080
*OIL: Reclaimed Oil From F.S.: 14617, NO. 2 OIL: 5736

PREPARED BY: Vlasne L. Bowman
DATE: 10 Feb. '93

APPROVED BY:
DATE:

POST ENGINEER:
DATE:

SEE REVERSE SIDE FOR INSTRUCTIONS

# MAKE-UP WATER DATA

Fort Stewart Central Energy Plant
Filename: F-MAKEUP.WQ1

HTW System Makeup Water

| Month | Year | WS Makeup Gal(1) | Days/ Month | Avg WS Makeup Gal/Day | Max WS Makeup Gal/Day | Min WS Makeup Gal/Day | Max WS Makeup Gal/Min | Avg WS Makeup Gal/Min | Min WS Makeup Gal/Min |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 93 | 324080 | 31 | 10454 | 16570 | 6100 | 11.5 | 7.3 | 4.2 |
| 2 | 93 | 400920 | 28 | 14319 | 18450 | 8930 | 12.8 | 9.9 | 6.2 |
| 3 | 93 | 386430 | 31 | 12465 | 21990 | 1001 | 15.3 | 8.7 | 0.7 |
| 4 | 93 | 425830 | 30 | 14194 | 25710 | 8140 | 17.9 | 9.9 | 5.7 |
| 5 | 93 | 258830 | 31 | 8349 | 14710 | 4980 | 10.2 | 5.8 | 3.5 |
| 6 | 93 | 312260 | 30 | 10409 | 19070 | 7600 | 13.2 | 7.2 | 5.3 |
| 7 | 93 | 388480 | 31 | 12532 | 16000 | 7630 | 11.1 | 8.7 | 5.3 |
| 8 | 93 | 432570 | 31 | 13954 | 26530 | 8970 | 18.4 | 9.7 | 6.2 |
| 9 | 93 | 358820 | 30 | 11961 | 17160 | 6310 | 11.9 | 8.3 | 4.4 |
| 10 | 93 | 391750 | 31 | 12637 | 19420 | 7500 | 13.5 | 8.8 | 5.2 |
| 11 | 93 | 477570 | 30 | 15919 | 23970 | 9580 | 16.6 | 11.1 | 6.7 |
| 12 | 93 | 531190 | 31 | 17135 | 27800 | 9850 | 19.3 | 11.9 | 6.8 |
| 1 | 94 | 626020 | 31 | 20194 | 27840 | 14630 | 19.3 | 14.0 | 10.2 |
| 2 | 94 | 551230 | 28 | 19687 | 26080 | 14200 | 18.1 | 13.7 | 9.9 |
| 3 | 94 | 793890 | 31 | 25609 | 31750 | 17320 | 22.0 | 17.8 | 12.0 |
| 4 | 94 | 453420 | 30 | 15114 | 27130 | 3840 | 18.8 | 10.5 | 2.7 |
| 5 | 94 | 309740 | 31 | 9992 | 14070 | 5510 | 9.8 | 6.9 | 3.8 |
| 6 | 94 | 352590 | 30 | 11753 | 17920 | 4580 | 12.4 | 8.2 | 3.2 |
| 7 | 94 | 540670 | 31 | 17441 | 25130 | 10620 | 17.5 | 12.1 | 7.4 |
| 8 | 94 | 404010 | 31 | 13033 | 19920 | 5240 | 13.8 | 9.1 | 3.6 |
| 9 | 94 | 246270 | 30 | 8209 | 17800 | 1390 | 12.4 | 5.7 | 1.0 |
| 10 | 94 | 136380 | 31 | 4399 | 12550 | 900 | 8.7 | 3.1 | 0.6 |
| 11 | 94 | 442980 | 30 | 14766 | 23010 | 1910 | 16.0 | 10.3 | 1.3 |
| 12 | 94 | 419160 | 31 | 13521 | 20800 | 7830 | 14.4 | 9.4 | 5.4 |
| 1 | 95 | 403420 | 31 | 13014 | 17980 | 8370 | 12.5 | 9.0 | 5.8 |
| 2 | 95 | 445340 | 28 | 15905 | 25150 | 11150 | 17.5 | 11.0 | 7.7 |
| 3 | 95 | 360940 | 31 | 11643 | 18680 | 7520 | 13.0 | 8.1 | 5.2 |
| 4 | 95 | 274470 | 30 | 9149 | 14330 | 5480 | 10.0 | 6.4 | 3.8 |
| 5 | 95 | 206480 | 31 | 6661 | 11300 | 2290 | 7.8 | 4.6 | 1.6 |
| 6 | 95 | 224250 | 30 | 7475 | 11450 | 4920 | 8.0 | 5.2 | 3.4 |
| 7 | 95 | 254190 | 31 | 8200 | 11360 | 3470 | 7.9 | 5.7 | 2.4 |
| 8 | 95 | 237210 | 31 | 7652 | 10490 | 5420 | 7.3 | 5.3 | 3.8 |
| 9 | 95 | 216450 | 30 | 7215 | 11980 | 3780 | 8.3 | 5.0 | 2.6 |
| 10 | 95 | 206690 | 31 | 6667 | 12230 | 3980 | 8.5 | 4.6 | 2.8 |
| 11 | 95 | 261230 | 30 | 8708 | 16220 | 2280 | 11.3 | 6.0 | 1.6 |
| 12 | 95 | 259510 | 31 | 8371 | 12610 | 4110 | 8.8 | 5.8 | 2.9 |
| 3 Yr | Min | 136380 | | 4399 | 10490 | 900 | 7.3 | 3.1 | 0.6 |
| | Avg | 369869 | | 12186 | 19032 | 6593 | 13.2 | 8.5 | 4.6 |
| | Max | 793890 | | 25609 | 31750 | 17320 | 22.0 | 17.8 | 12.0 |
| 1993 | Min | 258830 | | 8349 | 14710 | 1001 | 10.2 | 5.8 | 0.7 |
| | Avg | 390728 | | 12861 | 20615 | 7216 | 14.3 | 8.9 | 5.0 |
| | Max | 531190 | | 17135 | 27800 | 9850 | 19.3 | 11.9 | 6.8 |
| 1994 | Min | 136380 | | 4399 | 12550 | 900 | 8.7 | 3.1 | 0.6 |
| | Avg | 439697 | | 14477 | 22000 | 7331 | 15.3 | 10.1 | 5.1 |
| | Max | 793890 | | 25609 | 31750 | 17320 | 22.0 | 17.8 | 12.0 |
| 1995 | Min | 206480 | | 6661 | 10490 | 2280 | 7.3 | 4.6 | 1.6 |
| | Avg | 279182 | | 9222 | 14482 | 5231 | 10.1 | 6.4 | 3.6 |
| | Max | 445340 | | 15905 | 25150 | 11150 | 17.5 | 11.0 | 7.7 |

(1) Source is Fort Stewart Boiler Operating Logs.
WS - Water softener makeup water from meter readings.

1995 DAILY MAKEUP WATER

| MONTH | DAY | GAL/DAY | TOTAL | AVG GPD | GAL/MIN | AVG GPM |
|---|---|---|---|---|---|---|
| | 1 | 12340 | | | 8.6 | |
| | 2 | 14200 | | | 9.9 | |
| | 3 | 11070 | | | 7.7 | |
| | 4 | 16470 | | | 11.4 | |
| | 5 | 14790 | | | 10.3 | |
| | 6 | 8750 | | | 6.1 | |
| | 7 | 11670 | | | 8.1 | |
| | 8 | 11310 | | | 7.9 | |
| | 9 | 10650 | | | 7.4 | |
| | 10 | 12070 | | | 8.4 | |
| | 11 | 8370 | | | 5.8 | |
| | 12 | 10090 | | | 7.0 | |
| | 13 | 15170 | | | 10.5 | |
| | 14 | 13320 | | | 9.3 | |
| JAN | 15 | 15450 | | 13014 | 10.7 | 9.0 |
| | 16 | 15060 | | | 10.5 | |
| | 17 | 15040 | | | 10.4 | |
| | 18 | 13900 | | | 9.7 | |
| | 19 | 17980 | | | 12.5 | |
| | 20 | 14010 | | | 9.7 | |
| | 21 | 9440 | | | 6.6 | |
| | 22 | 12120 | | | 8.4 | |
| | 23 | 16140 | | | 11.2 | |
| | 24 | 13080 | | | 9.1 | |
| | 25 | 14830 | | | 10.3 | |
| | 26 | 13280 | | | 9.2 | |
| | 27 | 14760 | | | 10.3 | |
| | 28 | 11050 | | | 7.7 | |
| | 29 | 11390 | | | 7.9 | |
| | 30 | 11720 | | | 8.1 | |
| | 31 | 13900 | 403420 | | 9.7 | |
| * | 1 | 14140 | | | 9.8 | |
| * | 2 | 15460 | | | 10.7 | |
| | 3 | 14990 | | | 10.4 | |
| | 4 | 16660 | | | 11.6 | |
| | 5 | 16630 | | | 11.5 | |
| | 6 | 12940 | | | 9.0 | |
| | 7 | 17370 | | | 12.1 | |
| | 8 | 17540 | | | 12.2 | |
| | 9 | 19240 | | | 13.4 | |
| | 10 | 17320 | | | 12.0 | |
| | 11 | 15500 | | | 10.8 | |
| | 12 | 14720 | | | 10.2 | |
| | 13 | 11430 | | | 7.9 | |
| FEB | 14 | 18050 | | 15905 | 12.5 | 11.0 |
| | 15 | 25150 | | | 17.5 | |
| | 16 | 14280 | | | 9.9 | |
| | 17 | 12940 | | | 9.0 | |
| | 18 | 11150 | | | 7.7 | |
| | 19 | 17920 | | | 12.4 | |
| | 20 | 11550 | | | 8.0 | |
| | 21 | 15790 | | | 11.0 | |
| | 22 | 13680 | | | 9.5 | |
| * | 23 | 17120 | | | 11.9 | |
| * | 24 | 14610 | | | 10.1 | |
| * | 25 | 16360 | | | 11.4 | |
| * | 26 | 15940 | | | 11.1 | |
| * | 27 | 24830 | | | 17.2 | |
| | 28 | 12030 | 445340 | | 8.4 | |

– ANNUAL STATS –

| | |
|---|---|
| AVG GPM | 6.4 |
| MIN GPM | 1.6 |
| MAX GPM | 17.5 |
| STD DEV | 2.5 |
| VARIANC | 6.0 |

FREQUENCY:

| GPM | NO. DAYS |
|---|---|
| 0 | 0 |
| 1 | 0 |
| 2 | 3 |
| 3 | 15 |
| 4 | 31 |
| 5 | 62 |
| 6 | 81 |
| 7 | 55 |
| 8 | 40 |
| 9 | 22 |
| 10 | 20 |
| 11 | 18 |
| 12 | 8 |
| 13 | 7 |
| 14 | 1 |
| 15 | 0 |
| 16 | 0 |
| 17 | 0 |
| 18 | 2 |
| 19 | 0 |
| 20 | 0 |
| 21 | 0 |
| 22 | 0 |
| 23 | 0 |
| 24 | 0 |
| 25 | 0 |

1995 DAILY MAKEUP WATER

| MONTH | DAY | GAL/DAY | TOTAL | AVG GPD | GAL/MIN | AVG GPM |
|---|---|---|---|---|---|---|
| | 1 | 18680 | | | 13.0 | |
| | 2 | 13870 | | | 9.6 | |
| | 3 | 7820 | | | 5.4 | |
| | 4 | 11000 | | | 7.6 | |
| | 5 | 13170 | | | 9.1 | |
| | 6 | 10400 | | | 7.2 | |
| | 7 | 9140 | | | 6.3 | |
| | 8 | 11970 | | | 8.3 | |
| | 9 | 14280 | | | 9.9 | |
| | 10 | 7520 | | | 5.2 | |
| | 11 | 11230 | | | 7.8 | |
| | 12 | 14350 | | | 10.0 | |
| | 13 | 12910 | | | 9.0 | |
| | 14 | 9820 | | | 6.8 | |
| MAR | 15 | 12110 | | 11643 | 8.4 | 8.1 |
| | 16 | 11250 | | | 7.8 | |
| | 17 | 13110 | | | 9.1 | |
| | 18 | 9570 | | | 6.6 | |
| | 19 | 9070 | | | 6.3 | |
| | 20 | 8530 | | | 5.9 | |
| | 21 | 9400 | | | 6.5 | |
| | 22 | 13730 | | | 9.5 | |
| | 23 | 12560 | | | 8.7 | |
| | 24 | 14620 | | | 10.2 | |
| | 25 | 11200 | | | 7.8 | |
| | 26 | 13030 | | | 9.0 | |
| | 27 | 11740 | | | 8.2 | |
| | 28 | 12100 | | | 8.4 | |
| | 29 | 10120 | | | 7.0 | |
| | 30 | 8060 | | | 5.6 | |
| | 31 | 14580 | 360940 | | 10.1 | |
| | 1 | 14330 | | | 10.0 | |
| | 2 | 9910 | | | 6.9 | |
| | 3 | 11410 | | | 7.9 | |
| | 4 | 11550 | | | 8.0 | |
| | 5 | 9830 | | | 6.8 | |
| | 6 | 12590 | | | 8.7 | |
| | 7 | 9140 | | | 6.3 | |
| | 8 | 10320 | | | 7.2 | |
| | 9 | 10890 | | | 7.6 | |
| | 10 | 10450 | | | 7.3 | |
| | 11 | 7720 | | | 5.4 | |
| | 12 | 7590 | | | 5.3 | |
| | 13 | 11020 | | | 7.7 | |
| | 14 | 10580 | | | 7.3 | |
| APR | 15 | 6900 | | 9149 | 4.8 | 6.4 |
| | 16 | 8440 | | | 5.9 | |
| | 17 | 7340 | | | 5.1 | |
| | 18 | 8490 | | | 5.9 | |
| | 19 | 8670 | | | 6.0 | |
| | 20 | 9790 | | | 6.8 | |
| | 21 | 7940 | | | 5.5 | |
| | 22 | 10940 | | | 7.6 | |
| | 23 | 8580 | | | 6.0 | |
| | 24 | 10600 | | | 7.4 | |
| | 25 | 7940 | | | 5.5 | |
| | 26 | 5740 | | | 4.0 | |
| | 27 | 6000 | | | 4.2 | |
| | 28 | 6450 | | | 4.5 | |
| | 29 | 7840 | | | 5.4 | |
| | 30 | 5480 | 274470 | | 3.8 | |

1995 DAILY MAKEUP WATER

| MONTH | DAY | GAL/DAY | TOTAL | AVG GPD | GAL/MIN | AVG GPM |
|---|---|---|---|---|---|---|
| | 1 | 5980 | | | 4.2 | |
| | 2 | 6010 | | | 4.2 | |
| | 3 | 8030 | | | 5.6 | |
| | 4 | 5320 | | | 3.7 | |
| | 5 | 4060 | | | 2.8 | |
| | 6 | 4220 | | | 2.9 | |
| | 7 | 3010 | | | 2.1 | |
| | 8 | 6450 | | | 4.5 | |
| | 9 | 3750 | | | 2.6 | |
| | 10 | 8950 | | | 6.2 | |
| | 11 | 8110 | | | 5.6 | |
| | 12 | 8800 | | | 6.1 | |
| | 13 | 6440 | | | 4.5 | |
| | 14 | 10390 | | | 7.2 | |
| MAY | 15 | 2290 | | 6661 | 1.6 | 4.6 |
| | 16 | 11300 | | | 7.8 | |
| | 17 | 7640 | | | 5.3 | |
| | 18 | 5090 | | | 3.5 | |
| | 19 | 7570 | | | 5.3 | |
| | 20 | 7480 | | | 5.2 | |
| | 21 | 7700 | | | 5.3 | |
| | 22 | 6610 | | | 4.6 | |
| | 23 | 5550 | | | 3.9 | |
| | 24 | 7630 | | | 5.3 | |
| | 25 | 8710 | | | 6.0 | |
| | 26 | 4480 | | | 3.1 | |
| | 27 | 6470 | | | 4.5 | |
| | 28 | 8600 | | | 6.0 | |
| | 29 | 6160 | | | 4.3 | |
| | 30 | 7890 | | | 5.5 | |
| | 31 | 5790 | 206480 | | 4.0 | |
| | 1 | 7500 | | | 5.2 | |
| | 2 | 6180 | | | 4.3 | |
| | 3 | 5920 | | | 4.1 | |
| | 4 | 8410 | | | 5.8 | |
| | 5 | 7600 | | | 5.3 | |
| | 6 | 9190 | | | 6.4 | |
| | 7 | 8430 | | | 5.9 | |
| | 8 | 5840 | | | 4.1 | |
| | 9 | 5910 | | | 4.1 | |
| | 10 | 5520 | | | 3.8 | |
| | 11 | 8310 | | | 5.8 | |
| | 12 | 9230 | | | 6.4 | |
| | 13 | 11450 | | | 8.0 | |
| | 14 | 6480 | | | 4.5 | |
| JUN | 15 | 5440 | | 7475 | 3.8 | 5.2 |
| | 16 | 7380 | | | 5.1 | |
| | 17 | 8080 | | | 5.6 | |
| | 18 | 7860 | | | 5.5 | |
| | 19 | 5700 | | | 4.0 | |
| | 20 | 5630 | | | 3.9 | |
| | 21 | 6830 | | | 4.7 | |
| | 22 | 9310 | | | 6.5 | |
| | 23 | 9960 | | | 6.9 | |
| | 24 | 7900 | | | 5.5 | |
| | 25 | 7090 | | | 4.9 | |
| | 26 | 6240 | | | 4.3 | |
| | 27 | 8960 | | | 6.2 | |
| | 28 | 9520 | | | 6.6 | |
| | 29 | 7460 | | | 5.2 | |
| | 30 | 4920 | 224250 | | 3.4 | |

1995 DAILY MAKEUP WATER

| MONT | DAY | GAL/DAY | TOTAL | AVG GPD | GAL/MIN | AVG GPM |
|---|---|---|---|---|---|---|
| | 1 | 4430 | | | 3.1 | |
| | 2 | 10620 | | | 7.4 | |
| | 3 | 3470 | | | 2.4 | |
| | 4 | 6990 | | | 4.9 | |
| | 5 | 6240 | | | 4.3 | |
| | 6 | 7810 | | | 5.4 | |
| | 7 | 7480 | | | 5.2 | |
| | 8 | 8010 | | | 5.6 | |
| | 9 | 9520 | | | 6.6 | |
| | 10 | 8050 | | | 5.6 | |
| | 11 | 6780 | | | 4.7 | |
| | 12 | 9470 | | | 6.6 | |
| | 13 | 4470 | | | 3.1 | |
| | 14 | 5610 | | | 3.9 | |
| JUL | 15 | 8480 | | 8200 | 5.9 | 5.7 |
| | 16 | 8390 | | | 5.8 | |
| | 17 | 7710 | | | 5.4 | |
| | 18 | 7640 | | | 5.3 | |
| | 19 | 9320 | | | 6.5 | |
| | 20 | 9930 | | | 6.9 | |
| | 21 | 9370 | | | 6.5 | |
| | 22 | 9080 | | | 6.3 | |
| | 23 | 7480 | | | 5.2 | |
| | 24 | 8180 | | | 5.7 | |
| | 25 | 11360 | | | 7.9 | |
| | 26 | 11130 | | | 7.7 | |
| | * 27 | 9760 | | | 6.8 | |
| | 28 | 10420 | | | 7.2 | |
| | 29 | 8090 | | | 5.6 | |
| | 30 | 9080 | | | 6.3 | |
| | 31 | 9820 | 254190 | | 6.8 | |
| | 1 | 8710 | | | 6.0 | |
| | 2 | 9470 | | | 6.6 | |
| | 3 | 9580 | | | 6.7 | |
| | 4 | 7020 | | | 4.9 | |
| | 5 | 10200 | | | 7.1 | |
| | 6 | 8420 | | | 5.8 | |
| | 7 | 10430 | | | 7.2 | |
| | 8 | 7210 | | | 5.0 | |
| | 9 | 5910 | | | 4.1 | |
| | 10 | 7260 | | | 5.0 | |
| | 11 | 6470 | | | 4.5 | |
| | 12 | 8320 | | | 5.8 | |
| | 13 | 6970 | | | 4.8 | |
| | 14 | 6640 | | | 4.6 | |
| AUG | 15 | 8410 | | 7652 | 5.8 | 5.3 |
| | 16 | 7340 | | | 5.1 | |
| | 17 | 6900 | | | 4.8 | |
| | 18 | 7630 | | | 5.3 | |
| | 19 | 6560 | | | 4.6 | |
| | 20 | 5820 | | | 4.0 | |
| | 21 | 8020 | | | 5.6 | |
| | 22 | 5420 | | | 3.8 | |
| | 23 | 5720 | | | 4.0 | |
| | 24 | 6840 | | | 4.8 | |
| | 25 | 10490 | | | 7.3 | |
| | 26 | 7220 | | | 5.0 | |
| | 27 | 8840 | | | 6.1 | |
| | 28 | 8430 | | | 5.9 | |
| | 29 | 7290 | | | 5.1 | |
| | 30 | 6740 | | | 4.7 | |
| | 31 | 6930 | 237210 | | 4.8 | |

1995 DAILY MAKEUP WATER

| MONTH | DAY | GAL/DAY | TOTAL | AVG GPD | GAL/MIN | AVG GPM |
|---|---|---|---|---|---|---|
| | 1 | 6230 | | | 4.3 | |
| | 2 | 7940 | | | 5.5 | |
| | 3 | 8070 | | | 5.6 | |
| | 4 | 7700 | | | 5.3 | |
| | 5 | 7500 | | | 5.2 | |
| | 6 | 8860 | | | 6.2 | |
| | 7 | 5560 | | | 3.9 | |
| | 8 | 10300 | | | 7.2 | |
| | 9 | 7020 | | | 4.9 | |
| | 10 | 8560 | | | 5.9 | |
| | 11 | 6130 | | | 4.3 | |
| | 12 | 6120 | | | 4.3 | |
| | 13 | 6990 | | | 4.9 | |
| | 14 | 11980 | | | 8.3 | |
| SEP | 15 | 6280 | | 7215 | 4.4 | 5.0 |
| | 16 | 8570 | | | 6.0 | |
| | 17 | 7990 | | | 5.5 | |
| | 18 | 8650 | | | 6.0 | |
| | 19 | 8510 | | | 5.9 | |
| | 20 | 9720 | | | 6.8 | |
| | 21 | 7250 | | | 5.0 | |
| | 22 | 6760 | | | 4.7 | |
| | 23 | 4550 | | | 3.2 | |
| | 24 | 6280 | | | 4.4 | |
| | 25 | 6330 | | | 4.4 | |
| | 26 | 3780 | | | 2.6 | |
| | 27 | 4080 | | | 2.8 | |
| | 28 | 7400 | | | 5.1 | |
| | 29 | 5020 | | | 3.5 | |
| | 30 | 6320 | 216450 | | 4.4 | |
| | 1 | 4280 | | | 3.0 | |
| | 2 | 4230 | | | 2.9 | |
| | 3 | 6570 | | | 4.6 | |
| | 4 | 6580 | | | 4.6 | |
| | 5 | 6180 | | | 4.3 | |
| | 6 | 5740 | | | 4.0 | |
| | 7 | 7050 | | | 4.9 | |
| | 8 | 6500 | | | 4.5 | |
| * | 9 | 5970 | | | 4.1 | |
| | 10 | 10080 | | | 7.0 | |
| | 11 | 12230 | | | 8.5 | |
| | 12 | 6710 | | | 4.7 | |
| | 13 | 7390 | | | 5.1 | |
| * | 14 | 11110 | | | 7.7 | |
| OCT | 15 | 7610 | | 6667 | 5.3 | 4.6 |
| | 16 | 8260 | | | 5.7 | |
| | 17 | 5620 | | | 3.9 | |
| | 18 | 6820 | | | 4.7 | |
| | 19 | 7070 | | | 4.9 | |
| | 20 | 7160 | | | 5.0 | |
| | 21 | 7740 | | | 5.4 | |
| | 22 | 7410 | | | 5.1 | |
| | 23 | 6120 | | | 4.3 | |
| | 24 | 4970 | | | 3.5 | |
| | 25 | 5040 | | | 3.5 | |
| | 26 | 5710 | | | 4.0 | |
| | 27 | 6750 | | | 4.7 | |
| | 28 | 4370 | | | 3.0 | |
| | 29 | 3980 | | | 2.8 | |
| | 30 | 6330 | | | 4.4 | |
| | 31 | 5110 | 206690 | | 3.5 | |

1995 DAILY MAKEUP WATER

| MONTH | DAY | GAL/DAY | TOTAL | AVG GPD | GAL/MIN | AVG GPM |
|---|---|---|---|---|---|---|
| | 1 | 4020 | | | 2.8 | |
| | 2 | 5090 | | | 3.5 | |
| | 3 | 3730 | | | 2.6 | |
| | 4 | 7330 | | | 5.1 | |
| | 5 | 2280 | | | 1.6 | |
| | 6 | 7650 | | | 5.3 | |
| | 7 | 2440 | | | 1.7 | |
| | 8 | 3700 | | | 2.6 | |
| | 9 | 9110 | | | 6.3 | |
| | 10 | 10140 | | | 7.0 | |
| | 11 | 5410 | | | 3.8 | |
| | 12 | 6830 | | | 4.7 | |
| | 13 | 10080 | | | 7.0 | |
| | 14 | 9320 | | | 6.5 | |
| NOV | 15 | 12200 | | 8708 | 8.5 | 6.0 |
| | 16 | 13450 | | | 9.3 | |
| | 17 | 16220 | | | 11.3 | |
| | 18 | 14560 | | | 10.1 | |
| | 19 | 10130 | | | 7.0 | |
| | 20 | 13380 | | | 9.3 | |
| | 21 | 14530 | | | 10.1 | |
| | 22 | 14460 | | | 10.0 | |
| | 23 | 10020 | | | 7.0 | |
| | 24 | 7950 | | | 5.5 | |
| | 25 | 11720 | | | 8.1 | |
| | 26 | 4100 | | | 2.8 | |
| | 27 | 4450 | | | 3.1 | |
| | 28 | 10070 | | | 7.0 | |
| | 29 | 9450 | | | 6.6 | |
| | 30 | 7410 | 261230 | | 5.1 | |
| | 1 | 7430 | | | 5.2 | |
| | 2 | 9300 | | | 6.5 | |
| | 3 | 10090 | | | 7.0 | |
| | 4 | 8930 | | | 6.2 | |
| | 5 | 9170 | | | 6.4 | |
| | 6 | 6500 | | | 4.5 | |
| | 7 | 9930 | | | 6.9 | |
| | 8 | 7770 | | | 5.4 | |
| | 9 | 7430 | | | 5.2 | |
| | 10 | 9410 | | | 6.5 | |
| | 11 | 9100 | | | 6.3 | |
| | 12 | 8010 | | | 5.6 | |
| | 13 | 9780 | | | 6.8 | |
| | 14 | 9470 | | | 6.6 | |
| DEC | 15 | 10930 | | 8371 | 7.6 | 5.8 |
| | 16 | 8650 | | | 6.0 | |
| | 17 | 9770 | | | 6.8 | |
| | 18 | 8500 | | | 5.9 | |
| | 19 | 6790 | | | 4.7 | |
| | 20 | 7300 | | | 5.1 | |
| | 21 | 7620 | | | 5.3 | |
| | 22 | 4110 | | | 2.9 | |
| | 23 | 6220 | | | 4.3 | |
| | 24 | 7180 | | | 5.0 | |
| | 25 | 4420 | | | 3.1 | |
| | 26 | 5050 | | | 3.5 | |
| | 27 | 7010 | | | 4.9 | |
| | 28 | 9310 | | | 6.5 | |
| | 29 | 10690 | | | 7.4 | |
| | 30 | 11030 | | | 7.7 | |
| | 31 | 12610 | 259510 | | 8.8 | |

1994 DAILY MAKEUP WATER

| MONTH | DAY | GAL/DAY | TOTAL | AVG GPD | GAL/MIN | AVG GPM |
|---|---|---|---|---|---|---|
| | 1 | 19660 | | | 13.7 | |
| | 2 | 22970 | | | 16.0 | |
| | 3 | 27360 | | | 19.0 | |
| | 4 | 14630 | | | 10.2 | |
| | 5 | 15970 | | | 11.1 | |
| | 6 | 19580 | | | 13.6 | |
| | 7 | 24220 | | | 16.8 | |
| | 8 | 25780 | | | 17.9 | |
| | 9 | 26590 | | | 18.5 | |
| | 10 | 26270 | | | 18.2 | |
| | 11 | 27840 | | | 19.3 | |
| | 12 | 22680 | | | 15.8 | |
| | 13 | 22050 | | | 15.3 | |
| | 14 | 15020 | | | 10.4 | |
| JAN | 15 | 21080 | | 20194 | 14.6 | 14.0 |
| | 16 | 22930 | | | 15.9 | |
| | 17 | 17550 | | | 12.2 | |
| | 18 | 20730 | | | 14.4 | |
| | 19 | 23850 | | | 16.6 | |
| | 20 | 22130 | | | 15.4 | |
| | 21 | 18870 | | | 13.1 | |
| | 22 | 18690 | | | 13.0 | |
| | 23 | 16020 | | | 11.1 | |
| | 24 | 19140 | | | 13.3 | |
| | 25 | 17180 | | | 11.9 | |
| | 26 | 14130 | | | 9.8 | |
| | 27 | 17120 | | | 11.9 | |
| | 28 | 16350 | | | 11.4 | |
| | 29 | 17580 | | | 12.2 | |
| | 30 | 14480 | | | 10.1 | |
| | 31 | 17570 | 626020 | | 12.2 | |
| | 1 | 14200 | | | 9.9 | |
| | 2 | 17160 | | | 11.9 | |
| | 3 | 17440 | | | 12.1 | |
| | 4 | 15090 | | | 10.5 | |
| | 5 | 15960 | | | 11.1 | |
| | 6 | 20770 | | | 14.4 | |
| | 7 | 15340 | | | 10.7 | |
| | 8 | 17870 | | | 12.4 | |
| | 9 | 19420 | | | 13.5 | |
| | 10 | 18420 | | | 12.8 | |
| | 11 | 20090 | | | 14.0 | |
| | 12 | 19010 | | | 13.2 | |
| | 13 | 18160 | | | 12.6 | |
| FEB | 14 | 21660 | | 19687 | 15.0 | 13.7 |
| | 15 | 20380 | | | 14.2 | |
| | 16 | 23820 | | | 16.5 | |
| | 17 | 20440 | | | 14.2 | |
| | 18 | 16770 | | | 11.6 | |
| | 19 | 20080 | | | 13.9 | |
| | 20 | 25150 | | | 17.5 | |
| | 21 | 21440 | | | 14.9 | |
| | 22 | 21490 | | | 14.9 | |
| | 23 | 26080 | | | 18.1 | |
| | 24 | 22740 | | | 15.8 | |
| | 25 | 21170 | | | 14.7 | |
| | 26 | 21720 | | | 15.1 | |
| | 27 | 19240 | | | 13.4 | |
| | 28 | 20120 | 551230 | | 14.0 | |

– ANNUAL STATS –

| | |
|---|---|
| AVG GPM | 10.0 |
| MIN GPM | 0.6 |
| MAX GPM | 22.0 |
| STD DEV | 4.7 |
| VARIANC | 22.1 |

FREQUENCY:

| GPM | NO. DAYS |
|---|---|
| 0 | 0 |
| 1 | 5 |
| 2 | 18 |
| 3 | 3 |
| 4 | 9 |
| 5 | 9 |
| 6 | 25 |
| 7 | 35 |
| 8 | 36 |
| 9 | 25 |
| 10 | 25 |
| 11 | 24 |
| 12 | 25 |
| 13 | 28 |
| 14 | 21 |
| 15 | 16 |
| 16 | 18 |
| 17 | 14 |
| 18 | 8 |
| 19 | 10 |
| 20 | 7 |
| 21 | 1 |
| 22 | 2 |
| 23 | 1 |
| 24 | 0 |
| 25 | 0 |

1994 DAILY MAKEUP WATER

| MONTH | DAY | GAL/DAY | TOTAL | AVG GPD | GAL/MIN | AVG GPM |
|---|---|---|---|---|---|---|
| | 1 | 25100 | | | 17.4 | |
| | 2 | 20320 | | | 14.1 | |
| | 3 | 23790 | | | 16.5 | |
| | 4 | 22910 | | | 15.9 | |
| | 5 | 17320 | | | 12.0 | |
| | 6 | 25540 | | | 17.7 | |
| | 7 | 23860 | | | 16.6 | |
| | 8 | 22170 | | | 15.4 | |
| | 9 | 20290 | | | 14.1 | |
| | 10 | 26490 | | | 18.4 | |
| | 11 | 28540 | | | 19.8 | |
| | 12 | 23920 | | | 16.6 | |
| | 13 | 23450 | | | 16.3 | |
| | 14 | 27460 | | | 19.1 | |
| MAR | 15 | 25260 | | 25609 | 17.5 | 17.8 |
| | 16 | 26090 | | | 18.1 | |
| | 17 | 26040 | | | 18.1 | |
| | 18 | 23560 | | | 16.4 | |
| | 19 | 24360 | | | 16.9 | |
| | 20 | 29390 | | | 20.4 | |
| | 21 | 28510 | | | 19.8 | |
| | 22 | 26570 | | | 18.5 | |
| | 23 | 28150 | | | 19.5 | |
| | 24 | 27000 | | | 18.8 | |
| | 25 | 31750 | | | 22.0 | |
| | 26 | 24160 | | | 16.8 | |
| | 27 | 27560 | | | 19.1 | |
| | 28 | 31250 | | | 21.7 | |
| | 29 | 31630 | | | 22.0 | |
| | 30 | 28450 | | | 19.8 | |
| | 31 | 23000 | 793890 | | 16.0 | |
| | 1 | 22740 | | | 15.8 | |
| | 2 | 27130 | | | 18.8 | |
| | 3 | 22670 | | | 15.7 | |
| | 4 | 22190 | | | 15.4 | |
| | 5 | 23930 | | | 16.6 | |
| | 6 | 24730 | | | 17.2 | |
| | 7 | 24140 | | | 16.8 | |
| | 8 | 20050 | | | 13.9 | |
| | 9 | 22500 | | | 15.6 | |
| | 10 | 21360 | | | 14.8 | |
| | 11 | 25540 | | | 17.7 | |
| | 12 | 16220 | | | 11.3 | |
| | 13 | 24130 | | | 16.8 | |
| | 14 | 10810 | | | 7.5 | |
| APR | 15 | 4740 | | 15114 | 3.3 | 10.5 |
| | 16 | 4500 | | | 3.1 | |
| | 17 | 10250 | | | 7.1 | |
| | 18 | 10280 | | | 7.1 | |
| | 19 | 13500 | | | 9.4 | |
| | 20 | 10280 | | | 7.1 | |
| | 21 | 8250 | | | 5.7 | |
| | 22 | 3840 | | | 2.7 | |
| | 23 | 4600 | | | 3.2 | |
| | 24 | 10260 | | | 7.1 | |
| | 25 | 9830 | | | 6.8 | |
| | 26 | 10130 | | | 7.0 | |
| | 27 | 10010 | | | 7.0 | |
| | 28 | 7180 | | | 5.0 | |
| | 29 | 13110 | | | 9.1 | |
| | 30 | 14520 | 453420 | | 10.1 | |

1994 DAILY MAKEUP WATER

| MONTH | DAY | GAL/DAY | TOTAL | AVG GPD | GAL/MIN | AVG GPM |
|---|---|---|---|---|---|---|
| | 1 | 9870 | | | 6.9 | |
| | 2 | 14070 | | | 9.8 | |
| | 3 | 7580 | | | 5.3 | |
| | 4 | 9980 | | | 6.9 | |
| | 5 | 11910 | | | 8.3 | |
| | 6 | 7940 | | | 5.5 | |
| | 7 | 12030 | | | 8.4 | |
| | 8 | 9730 | | | 6.8 | |
| | 9 | 8760 | | | 6.1 | |
| | 10 | 9730 | | | 6.8 | |
| | 11 | 11390 | | | 7.9 | |
| | 12 | 8350 | | | 5.8 | |
| | 13 | 9510 | | | 6.6 | |
| | 14 | 11480 | | | 8.0 | |
| MAY | 15 | 8280 | | 9992 | 5.8 | 6.9 |
| | 16 | 5680 | | | 3.9 | |
| | 17 | 10250 | | | 7.1 | |
| | 18 | 7530 | | | 5.2 | |
| | 19 | 9460 | | | 6.6 | |
| | 20 | 11870 | | | 8.2 | |
| | 21 | 12320 | | | 8.6 | |
| | 22 | 11510 | | | 8.0 | |
| | 23 | 8470 | | | 5.9 | |
| | 24 | 12550 | | | 8.7 | |
| | 25 | 9700 | | | 6.7 | |
| | 26 | 10950 | | | 7.6 | |
| | 27 | 10170 | | | 7.1 | |
| | 28 | 7960 | | | 5.5 | |
| | 29 | 9910 | | | 6.9 | |
| | 30 | 8850 | | | 6.1 | |
| | 31 | 11950 | 309740 | | 8.3 | |
| | 1 | 7550 | | | 5.2 | |
| | 2 | 13240 | | | 9.2 | |
| | 3 | 10770 | | | 7.5 | |
| | 4 | 10470 | | | 7.3 | |
| | 5 | 8960 | | | 6.2 | |
| | 6 | 9080 | | | 6.3 | |
| | 7 | 11300 | | | 7.8 | |
| | 8 | 9000 | | | 6.3 | |
| | 9 | 4580 | | | 3.2 | |
| | 10 | 8000 | | | 5.6 | |
| | 11 | 9520 | | | 6.6 | |
| | 12 | 11130 | | | 7.7 | |
| | 13 | 12140 | | | 8.4 | |
| | 14 | 9190 | | | 6.4 | |
| JUN | 15 | 12370 | | 11753 | 8.6 | 8.2 |
| | 16 | 11090 | | | 7.7 | |
| | 17 | 14450 | | | 10.0 | |
| | 18 | 11890 | | | 8.3 | |
| | 19 | 11050 | | | 7.7 | |
| | 20 | 14080 | | | 9.8 | |
| | 21 | 14310 | | | 9.9 | |
| | 22 | 17920 | | | 12.4 | |
| | 23 | 9720 | | | 6.8 | |
| | 24 | 15530 | | | 10.8 | |
| | 25 | 14020 | | | 9.7 | |
| | 26 | 15320 | | | 10.6 | |
| | 27 | 14220 | | | 9.9 | |
| | 28 | 14180 | | | 9.8 | |
| | 29 | 12200 | | | 8.5 | |
| | 30 | 15310 | 352590 | | 10.6 | |

1994 DAILY MAKEUP WATER

| MONT | DAY | GAL/DAY | TOTAL | AVG GPD | GAL/MIN | AVG GPM |
|---|---|---|---|---|---|---|
| | 1 | 12920 | | | 9.0 | |
| | 2 | 15930 | | | 11.1 | |
| | 3 | 12250 | | | 8.5 | |
| | 4 | 12760 | | | 8.9 | |
| | 5 | 13570 | | | 9.4 | |
| | 6 | 10620 | | | 7.4 | |
| | 7 | 21960 | | | 15.3 | |
| | 8 | 14500 | | | 10.1 | |
| | 9 | 18370 | | | 12.8 | |
| | 10 | 15400 | | | 10.7 | |
| | 11 | 17130 | | | 11.9 | |
| | 12 | 17310 | | | 12.0 | |
| | 13 | 25130 | | | 17.5 | |
| | 14 | 21390 | | | 14.9 | |
| JUL | 15 | 13200 | | 17441 | 9.2 | 12.1 |
| | 16 | 18480 | | | 12.8 | |
| | 17 | 17870 | | | 12.4 | |
| | 18 | 18070 | | | 12.5 | |
| | 19 | 20870 | | | 14.5 | |
| | 20 | 18490 | | | 12.8 | |
| | 21 | 21440 | | | 14.9 | |
| | 22 | 17360 | | | 12.1 | |
| | 23 | 17800 | | | 12.4 | |
| | 24 | 15020 | | | 10.4 | |
| | 25 | 20240 | | | 14.1 | |
| | 26 | 18840 | | | 13.1 | |
| | 27 | 17160 | | | 11.9 | |
| | 28 | 19530 | | | 13.6 | |
| | 29 | 16960 | | | 11.8 | |
| | 30 | 23240 | | | 16.1 | |
| | 31 | 16860 | 540670 | | 11.7 | |
| | 1 | 19920 | | | 13.8 | |
| | 2 | 17770 | | | 12.3 | |
| | 3 | 18120 | | | 12.6 | |
| | 4 | 19050 | | | 13.2 | |
| | 5 | 13080 | | | 9.1 | |
| | 6 | 13540 | | | 9.4 | |
| | 7 | 16090 | | | 11.2 | |
| | 8 | 17210 | | | 12.0 | |
| | 9 | 16420 | | | 11.4 | |
| | 10 | 12430 | | | 8.6 | |
| | 11 | 17110 | | | 11.9 | |
| | 12 | 14850 | | | 10.3 | |
| | 13 | 15990 | | | 11.1 | |
| | 14 | 15020 | | | 10.4 | |
| AUG | 15 | 18590 | | 13033 | 12.9 | 9.1 |
| | 16 | 17880 | | | 12.4 | |
| | 17 | 13990 | | | 9.7 | |
| | 18 | 11160 | | | 7.8 | |
| | 19 | 5240 | | | 3.6 | |
| | 20 | 9080 | | | 6.3 | |
| | 21 | 10430 | | | 7.2 | |
| | 22 | 9310 | | | 6.5 | |
| | 23 | 6640 | | | 4.6 | |
| | 24 | 11450 | | | 8.0 | |
| | 25 | 8500 | | | 5.9 | |
| | 26 | 5730 | | | 4.0 | |
| | 27 | 9470 | | | 6.6 | |
| | 28 | 11630 | | | 8.1 | |
| | 29 | 12460 | | | 8.7 | |
| | 30 | 8540 | | | 5.9 | |
| | 31 | 7310 | 404010 | | 5.1 | |

1994 DAILY MAKEUP WATER

| MONTH | DAY | GAL/DAY | TOTAL | AVG GPD | GAL/MIN | AVG GPM |
|---|---|---|---|---|---|---|
| | 1 | 6740 | | | 4.7 | |
| | 2 | 10850 | | | 7.5 | |
| | 3 | 7990 | | | 5.5 | |
| | 4 | 7390 | | | 5.1 | |
| | 5 | 5060 | | | 3.5 | |
| | 6 | 17800 | | | 12.4 | |
| | 7 | 9440 | | | 6.6 | |
| | 8 | 10420 | | | 7.2 | |
| | 9 | 8540 | | | 5.9 | |
| | 10 | 8200 | | | 5.7 | |
| | 11 | 8060 | | | 5.6 | |
| | 12 | 8320 | | | 5.8 | |
| | 13 | 5600 | | | 3.9 | |
| | 14 | 2070 | | | 1.4 | |
| SEP | 15 | 6840 | | 8209 | 4.8 | 5.7 |
| | 16 | 6950 | | | 4.8 | |
| | 17 | 7080 | | | 4.9 | |
| | 18 | 6980 | | | 4.8 | |
| | 19 | 9150 | | | 6.4 | |
| | 20 | 8690 | | | 6.0 | |
| | 21 | 8030 | | | 5.6 | |
| | 22 | 9870 | | | 6.9 | |
| | 23 | 9440 | | | 6.6 | |
| | 24 | 9970 | | | 6.9 | |
| | 25 | 1390 | | | 1.0 | |
| | 26 | 9570 | | | 6.6 | |
| | 27 | 9170 | | | 6.4 | |
| | 28 | 10480 | | | 7.3 | |
| | 29 | 8210 | | | 5.7 | |
| | 30 | 7970 | 246270 | | 5.5 | |
| | 1 | 7050 | | | 4.9 | |
| | 2 | 9190 | | | 6.4 | |
| | 3 | 10300 | | | 7.2 | |
| | 4 | 6730 | | | 4.7 | |
| | 5 | 8520 | | | 5.9 | |
| | 6 | 12550 | | | 8.7 | |
| | 7 | 11210 | | | 7.8 | |
| | 8 | 10010 | | | 7.0 | |
| | 9 | 9920 | | | 6.9 | |
| | 10 | 9460 | | | 6.6 | |
| | 11 | 2120 | | | 1.5 | |
| | 12 | 900 | | | 0.6 | |
| | 13 | 1600 | | | 1.1 | |
| | 14 | 1260 | | | 0.9 | |
| OCT | 15 | 2660 | | 4399 | 1.8 | 3.1 |
| | 16 | 2470 | | | 1.7 | |
| | 17 | 1840 | | | 1.3 | |
| | 18 | 2330 | | | 1.6 | |
| | 19 | 2140 | | | 1.5 | |
| | 20 | 1900 | | | 1.3 | |
| | 21 | 1730 | | | 1.2 | |
| | 22 | 3020 | | | 2.1 | |
| | 23 | 1390 | | | 1.0 | |
| | 24 | 2520 | | | 1.8 | |
| | 25 | 1950 | | | 1.4 | |
| | 26 | 2320 | | | 1.6 | |
| | 27 | 1830 | | | 1.3 | |
| | 28 | 1870 | | | 1.3 | |
| | 29 | 2140 | | | 1.5 | |
| | 30 | 950 | | | 0.7 | |
| | 31 | 2500 | 136380 | | 1.7 | |

1994 DAILY MAKEUP WATER

| MONTH | DAY | GAL/DAY | TOTAL | AVG GPD | GAL/MIN | AVG GPM |
|---|---|---|---|---|---|---|
| | 1 | 4120 | | | 2.9 | |
| | 2 | 1910 | | | 1.3 | |
| | 3 | 13180 | | | 9.2 | |
| | 4 | 16220 | | | 11.3 | |
| | 5 | 15080 | | | 10.5 | |
| | 6 | 14900 | | | 10.3 | |
| | 7 | 12210 | | | 8.5 | |
| | 8 | 15360 | | | 10.7 | |
| | 9 | 18450 | | | 12.8 | |
| | 10 | 16470 | | | 11.4 | |
| | 11 | 13860 | | | 9.6 | |
| | 12 | 14480 | | | 10.1 | |
| | 13 | 13250 | | | 9.2 | |
| | 14 | 19840 | | | 13.8 | |
| NOV | 15 | 22030 | | 14766 | 15.3 | 10.3 |
| | 16 | 11030 | | | 7.7 | |
| | 17 | 23010 | | | 16.0 | |
| | 18 | 12580 | | | 8.7 | |
| | 19 | 18870 | | | 13.1 | |
| | 20 | 18640 | | | 12.9 | |
| | 21 | 14180 | | | 9.8 | |
| | 22 | 17650 | | | 12.3 | |
| | 23 | 18870 | | | 13.1 | |
| | 24 | 13150 | | | 9.1 | |
| | 25 | 12510 | | | 8.7 | |
| | 26 | 13890 | | | 9.6 | |
| | 27 | 12370 | | | 8.6 | |
| | 28 | 14820 | | | 10.3 | |
| | 29 | 13580 | | | 9.4 | |
| | 30 | 16470 | 442980 | | 11.4 | |
| | 1 | 16310 | | | 11.3 | |
| | 2 | 17750 | | | 12.3 | |
| | 3 | 12720 | | | 8.8 | |
| | 4 | 13390 | | | 9.3 | |
| | 5 | 16600 | | | 11.5 | |
| | 6 | 18870 | | | 13.1 | |
| | 7 | 10970 | | | 7.6 | |
| | 8 | 11670 | | | 8.1 | |
| | 9 | 10380 | | | 7.2 | |
| | 10 | 14540 | | | 10.1 | |
| | 11 | 11660 | | | 8.1 | |
| | 12 | 15560 | | | 10.8 | |
| | 13 | 8080 | | | 5.6 | |
| | 14 | 10740 | | | 7.5 | |
| DEC | 15 | 10810 | | 13521 | 7.5 | 9.4 |
| | 16 | 13500 | | | 9.4 | |
| | 17 | 10170 | | | 7.1 | |
| | 18 | 10410 | | | 7.2 | |
| | 19 | 10490 | | | 7.3 | |
| | 20 | 19250 | | | 13.4 | |
| | 21 | 19410 | | | 13.5 | |
| | 22 | 15300 | | | 10.6 | |
| | 23 | 7830 | | | 5.4 | |
| | 24 | 10840 | | | 7.5 | |
| | 25 | 12690 | | | 8.8 | |
| | 26 | 9980 | | | 6.9 | |
| | 27 | 17900 | | | 12.4 | |
| | 28 | 16480 | | | 11.4 | |
| | 29 | 20800 | | | 14.4 | |
| | 30 | 9540 | | | 6.6 | |
| | 31 | 14520 | 419160 | | 10.1 | |

1993 DAILY MAKEUP WATER

| MONTH | DAY | GAL/DAY | TOTAL | AVG GPD | GAL/MIN | AVG GPM |
|---|---|---|---|---|---|---|
| | 1 | 9460 | | | 6.6 | |
| | 2 | 10430 | | | 7.2 | |
| | 3 | 14420 | | | 10.0 | |
| | 4 | 6100 | | | 4.2 | |
| | 5 | 9640 | | | 6.7 | |
| | 6 | 10480 | | | 7.3 | |
| | 7 | 11430 | | | 7.9 | |
| | 8 | 11100 | | | 7.7 | |
| | 9 | 9920 | | | 6.9 | |
| | 10 | 16570 | | | 11.5 | |
| | 11 | 8230 | | | 5.7 | |
| | 12 | 10850 | | | 7.5 | |
| | 13 | 11550 | | | 8.0 | |
| | 14 | 10170 | | | 7.1 | |
| JAN | 15 | 9770 | | 10454 | 6.8 | 7.3 |
| | 16 | 10350 | | | 7.2 | |
| | 17 | 11180 | | | 7.8 | |
| | 18 | 9600 | | | 6.7 | |
| | 19 | 11750 | | | 8.2 | |
| | 20 | 11790 | | | 8.2 | |
| | 21 | 6840 | | | 4.8 | |
| | 22 | 7260 | | | 5.0 | |
| | 23 | 11100 | | | 7.7 | |
| | 24 | 9130 | | | 6.3 | |
| | 25 | 10330 | | | 7.2 | |
| | 26 | 11960 | | | 8.3 | |
| | 27 | 10470 | | | 7.3 | |
| | 28 | 9710 | | | 6.7 | |
| | 29 | 10680 | | | 7.4 | |
| | 30 | 11010 | | | 7.6 | |
| | 31 | 10800 | 324080 | | 7.5 | |
| | 1 | 9170 | | | 6.4 | |
| | 2 | 13540 | | | 9.4 | |
| | 3 | 13330 | | | 9.3 | |
| | 4 | 10340 | | | 7.2 | |
| | 5 | 13000 | | | 9.0 | |
| | 6 | 8930 | | | 6.2 | |
| | 7 | 12480 | | | 8.7 | |
| | 8 | 11700 | | | 8.1 | |
| | 9 | 11550 | | | 8.0 | |
| | 10 | 13350 | | | 9.3 | |
| | 11 | 12680 | | | 8.8 | |
| | 12 | 13510 | | | 9.4 | |
| | 13 | 14130 | | | 9.8 | |
| FEB | 14 | 13920 | | 14319 | 9.7 | 9.9 |
| | 15 | 14040 | | | 9.8 | |
| | 16 | 18210 | | | 12.6 | |
| | 17 | 16830 | | | 11.7 | |
| | 18 | 13790 | | | 9.6 | |
| | 19 | 16060 | | | 11.2 | |
| | 20 | 15080 | | | 10.5 | |
| | 21 | 16030 | | | 11.1 | |
| | 22 | 16000 | | | 11.1 | |
| | 23 | 17780 | | | 12.3 | |
| | 24 | 18450 | | | 12.8 | |
| | 25 | 17890 | | | 12.4 | |
| | 26 | 18420 | | | 12.8 | |
| | 27 | 14460 | | | 10.0 | |
| | 28 | 16250 | 400920 | | 11.3 | |

– ANNUAL STATS –

| | |
|---|---|
| AVG GPM | 8.9 |
| MIN GPM | 0.7 |
| MAX GPM | 19.3 |
| STD DEV | 2.9 |
| VARIANC | 8.3 |

FREQUENCY:

| GPM | NO. DAYS |
|---|---|
| 0 | 0 |
| 1 | 2 |
| 2 | 0 |
| 3 | 1 |
| 4 | 4 |
| 5 | 12 |
| 6 | 27 |
| 7 | 44 |
| 8 | 60 |
| 9 | 54 |
| 10 | 54 |
| 11 | 34 |
| 12 | 22 |
| 13 | 23 |
| 14 | 7 |
| 15 | 6 |
| 16 | 4 |
| 17 | 6 |
| 18 | 2 |
| 19 | 2 |
| 20 | 1 |
| 21 | 0 |
| 22 | 0 |
| 23 | 0 |
| 24 | 0 |
| 25 | 0 |

1993 DAILY MAKEUP WATER

| MONTH | DAY | GAL/DAY | TOTAL | AVG GPD | GAL/MIN | AVG GPM |
|---|---|---|---|---|---|---|
| | 1 | 18040 | | | 12.5 | |
| | 2 | 16750 | | | 11.6 | |
| | 3 | 14370 | | | 10.0 | |
| | 4 | 16950 | | | 11.8 | |
| | 5 | 16710 | | | 11.6 | |
| | 6 | 14800 | | | 10.3 | |
| | 7 | 18500 | | | 12.8 | |
| | 8 | 21990 | | | 15.3 | |
| | 9 | 18800 | | | 13.1 | |
| | 10 | 18830 | | | 13.1 | |
| | 11 | 14170 | | | 9.8 | |
| | 12 | 11060 | | | 7.7 | |
| | 13 | 13390 | | | 9.3 | |
| | 14 | 6120 | | | 4.3 | |
| MAR | 15 | 9890 | | 12465 | 6.9 | 8.7 |
| | 16 | 9730 | | | 6.8 | |
| | 17 | 1000 | | | 0.7 | |
| | 18 | 1100 | | | 0.8 | |
| | 19 | 5530 | | | 3.8 | |
| | 20 | 9830 | | | 6.8 | |
| | 21 | 12150 | | | 8.4 | |
| | 22 | 14630 | | | 10.2 | |
| | 23 | 13280 | | | 9.2 | |
| | 24 | 8670 | | | 6.0 | |
| | 25 | 10170 | | | 7.1 | |
| | 26 | 12720 | | | 8.8 | |
| | 27 | 10550 | | | 7.3 | |
| | 28 | 9700 | | | 6.7 | |
| | 29 | 15510 | | | 10.8 | |
| | 30 | 12660 | | | 8.8 | |
| | 31 | 8830 | 386430 | | 6.1 | |
| | 1 | 11210 | | | 7.8 | |
| | 2 | 10680 | | | 7.4 | |
| | 3 | 12500 | | | 8.7 | |
| | 4 | 9920 | | | 6.9 | |
| | 5 | 13090 | | | 9.1 | |
| | 6 | 13340 | | | 9.3 | |
| | 7 | 8140 | | | 5.7 | |
| | 8 | 10130 | | | 7.0 | |
| | 9 | 12190 | | | 8.5 | |
| | 10 | 12720 | | | 8.8 | |
| | 11 | 12030 | | | 8.4 | |
| | 12 | 14470 | | | 10.0 | |
| | 13 | 14950 | | | 10.4 | |
| | 14 | 10090 | | | 7.0 | |
| APR | 15 | 13890 | | 14194 | 9.6 | 9.9 |
| | 16 | 13900 | | | 9.7 | |
| | 17 | 15350 | | | 10.7 | |
| | 18 | 13760 | | | 9.6 | |
| | 19 | 16130 | | | 11.2 | |
| | 20 | 15670 | | | 10.9 | |
| | 21 | 15070 | | | 10.5 | |
| | 22 | 12290 | | | 8.5 | |
| | 23 | 25730 | | | 17.9 | |
| | 24 | 17530 | | | 12.2 | |
| | 25 | 18320 | | | 12.7 | |
| | 26 | 18150 | | | 12.6 | |
| | 27 | 21060 | | | 14.6 | |
| | 28 | 16190 | | | 11.2 | |
| | 29 | 12800 | | | 8.9 | |
| | 30 | 14530 | 425830 | | 10.1 | |

1993 DAILY MAKEUP WATER

| MONTH | DAY | GAL/DAY | TOTAL | AVG GPD | GAL/MIN | AVG GPM |
|---|---|---|---|---|---|---|
| | 1 | 13080 | | | 9.1 | |
| | 2 | 14710 | | | 10.2 | |
| | 3 | 14360 | | | 10.0 | |
| | 4 | 9040 | | | 6.3 | |
| | 5 | 8880 | | | 6.2 | |
| | 6 | 9600 | | | 6.7 | |
| | 7 | 8560 | | | 5.9 | |
| | 8 | 8050 | | | 5.6 | |
| | 9 | 11450 | | | 8.0 | |
| | 10 | 14050 | | | 9.8 | |
| | 11 | 8020 | | | 5.6 | |
| | 12 | 7630 | | | 5.3 | |
| | 13 | 5300 | | | 3.7 | |
| | 14 | 7960 | | | 5.5 | |
| MAY | 15 | 6090 | | 8349 | 4.2 | 5.8 |
| | 16 | 6380 | | | 4.4 | |
| | 17 | 6750 | | | 4.7 | |
| | 18 | 3880 | | | 2.7 | |
| | 19 | 8330 | | | 5.8 | |
| | 20 | 6890 | | | 4.8 | |
| | 21 | 10360 | | | 7.2 | |
| | 22 | 7540 | | | 5.2 | |
| | 23 | 6950 | | | 4.8 | |
| | 24 | 5900 | | | 4.1 | |
| | 25 | 6390 | | | 4.4 | |
| | 26 | 4980 | | | 3.5 | |
| | 27 | 8180 | | | 5.7 | |
| | 28 | 7010 | | | 4.9 | |
| | 29 | 9110 | | | 6.3 | |
| | 30 | 5570 | | | 3.9 | |
| | 31 | 7830 | 258830 | | 5.4 | |
| | 1 | 8000 | | | 5.6 | |
| | 2 | 8610 | | | 6.0 | |
| | 3 | 7730 | | | 5.4 | |
| | 4 | 8560 | | | 5.9 | |
| | 5 | 7600 | | | 5.3 | |
| | 6 | 7600 | | | 5.3 | |
| | 7 | 10380 | | | 7.2 | |
| | 8 | 10600 | | | 7.4 | |
| | 9 | 8590 | | | 6.0 | |
| | 10 | 9200 | | | 6.4 | |
| | 11 | 8860 | | | 6.2 | |
| | 12 | 9080 | | | 6.3 | |
| | 13 | 7880 | | | 5.5 | |
| | 14 | 11640 | | | 8.1 | |
| JUN | 15 | 7560 | | 10409 | 5.3 | 7.2 |
| | 16 | 10910 | | | 7.6 | |
| | 17 | 10850 | | | 7.5 | |
| | 18 | 9320 | | | 6.5 | |
| | 19 | 9350 | | | 6.5 | |
| | 20 | 8700 | | | 6.0 | |
| | 21 | 10800 | | | 7.5 | |
| | 22 | 19040 | | | 13.2 | |
| | 23 | 12100 | | | 8.4 | |
| | 24 | 9390 | | | 6.5 | |
| | 25 | 12310 | | | 8.5 | |
| | 26 | 11990 | | | 8.3 | |
| | 27 | 12960 | | | 9.0 | |
| | 28 | 13050 | | | 9.1 | |
| | 29 | 14700 | | | 10.2 | |
| | 30 | 14900 | 312260 | | 10.3 | |

1993 DAILY MAKEUP WATER

| MONT | DAY | GAL/DAY | TOTAL | AVG GPD | GAL/MIN | AVG GPM |
|---|---|---|---|---|---|---|
| | 1 | 14560 | | | 10.1 | |
| | 2 | 10290 | | | 7.1 | |
| | 3 | 14220 | | | 9.9 | |
| | 4 | 14180 | | | 9.8 | |
| | 5 | 13620 | | | 9.5 | |
| | 6 | 13900 | | | 9.7 | |
| | 7 | 14670 | | | 10.2 | |
| | 8 | 13390 | | | 9.3 | |
| | 9 | 14630 | | | 10.2 | |
| | 10 | 12170 | | | 8.5 | |
| | 11 | 12960 | | | 9.0 | |
| | 12 | 14450 | | | 10.0 | |
| | 13 | 15640 | | | 10.9 | |
| | 14 | 13770 | | | 9.6 | |
| JUL | 15 | 14600 | | 12532 | 10.1 | 8.7 |
| | 16 | 16030 | | | 11.1 | |
| | 17 | 14040 | | | 9.8 | |
| | 18 | 14160 | | | 9.8 | |
| | 19 | 13000 | | | 9.0 | |
| | 20 | 14240 | | | 9.9 | |
| | 21 | 10830 | | | 7.5 | |
| | 22 | 11320 | | | 7.9 | |
| | 23 | 7630 | | | 5.3 | |
| | 24 | 9840 | | | 6.8 | |
| | 25 | 8500 | | | 5.9 | |
| | 26 | 9750 | | | 6.8 | |
| | 27 | 10090 | | | 7.0 | |
| | 28 | 10370 | | | 7.2 | |
| | 29 | 11650 | | | 8.1 | |
| | 30 | 10470 | | | 7.3 | |
| | 31 | 9510 | 388480 | | 6.6 | |
| | 1 | 10560 | | | 7.3 | |
| | 2 | 12220 | | | 8.5 | |
| | 3 | 10070 | | | 7.0 | |
| | 4 | 10050 | | | 7.0 | |
| | 5 | 8970 | | | 6.2 | |
| | 6 | 10750 | | | 7.5 | |
| | 7 | 10480 | | | 7.3 | |
| | 8 | 15120 | | | 10.5 | |
| | 9 | 13750 | | | 9.5 | |
| | 10 | 12340 | | | 8.6 | |
| | 11 | 12470 | | | 8.7 | |
| | 12 | 11780 | | | 8.2 | |
| | 13 | 11900 | | | 8.3 | |
| | 14 | 10400 | | | 7.2 | |
| AUG | 15 | 11780 | | 13954 | 8.2 | 9.7 |
| | 16 | 10050 | | | 7.0 | |
| | 17 | 12320 | | | 8.6 | |
| | 18 | 11710 | | | 8.1 | |
| | 19 | 16480 | | | 11.4 | |
| | 20 | 11350 | | | 7.9 | |
| | 21 | 10950 | | | 7.6 | |
| | 22 | 14100 | | | 9.8 | |
| | 23 | 12340 | | | 8.6 | |
| | 24 | 15240 | | | 10.6 | |
| | 25 | 16510 | | | 11.5 | |
| | 26 | 18270 | | | 12.7 | |
| | 27 | 17960 | | | 12.5 | |
| | 28 | 21740 | | | 15.1 | |
| | 29 | 21140 | | | 14.7 | |
| | 30 | 26530 | | | 18.4 | |
| | 31 | 23240 | 432570 | | 16.1 | |

1993 DAILY MAKEUP WATER

| MONTH | DAY | GAL/DAY | TOTAL | AVG GPD | GAL/MIN | AVG GPM |
|---|---|---|---|---|---|---|
| | 1 | 13990 | | | 9.7 | |
| | 2 | 11990 | | | 8.3 | |
| | 3 | 12520 | | | 8.7 | |
| | 4 | 10900 | | | 7.6 | |
| | 5 | 12610 | | | 8.8 | |
| | 6 | 15450 | | | 10.7 | |
| | 7 | 12290 | | | 8.5 | |
| | 8 | 9010 | | | 6.3 | |
| | 9 | 12550 | | | 8.7 | |
| | 10 | 10250 | | | 7.1 | |
| | 11 | 13230 | | | 9.2 | |
| | 12 | 12150 | | | 8.4 | |
| | 13 | 14510 | | | 10.1 | |
| | 14 | 13360 | | | 9.3 | |
| SEP | 15 | 13840 | | 11961 | 9.6 | 8.3 |
| | 16 | 12930 | | | 9.0 | |
| | 17 | 8570 | | | 6.0 | |
| | 18 | 12550 | | | 8.7 | |
| | 19 | 10440 | | | 7.3 | |
| | 20 | 6310 | | | 4.4 | |
| | 21 | 11060 | | | 7.7 | |
| | 22 | 10510 | | | 7.3 | |
| | 23 | 9220 | | | 6.4 | |
| | 24 | 8430 | | | 5.9 | |
| | 25 | 17800 | | | 12.4 | |
| | 26 | 15760 | | | 10.9 | |
| | 27 | 10750 | | | 7.5 | |
| | 28 | 10540 | | | 7.3 | |
| | 29 | 17160 | | | 11.9 | |
| | 30 | 8140 | 358820 | | 5.7 | |
| | 1 | 12050 | | | 8.4 | |
| | 2 | 9800 | | | 6.8 | |
| | 3 | 13030 | | | 9.0 | |
| | 4 | 9870 | | | 6.9 | |
| | 5 | 10180 | | | 7.1 | |
| | 6 | 17930 | | | 12.5 | |
| | 7 | 11340 | | | 7.9 | |
| | 8 | 9940 | | | 6.9 | |
| | 9 | 12920 | | | 9.0 | |
| | 10 | 12930 | | | 9.0 | |
| | 11 | 11560 | | | 8.0 | |
| | 12 | 13700 | | | 9.5 | |
| | 13 | 11490 | | | 8.0 | |
| | 14 | 9810 | | | 6.8 | |
| OCT | 15 | 11030 | | 12637 | 7.7 | 8.8 |
| | 16 | 10470 | | | 7.3 | |
| | 17 | 13630 | | | 9.5 | |
| | 18 | 12970 | | | 9.0 | |
| | 19 | 16120 | | | 11.2 | |
| | 20 | 16440 | | | 11.4 | |
| | 21 | 16250 | | | 11.3 | |
| | 22 | 9730 | | | 6.8 | |
| | 23 | 12270 | | | 8.5 | |
| | 24 | 11200 | | | 7.8 | |
| | 25 | 7500 | | | 5.2 | |
| | 26 | 13800 | | | 9.6 | |
| | 27 | 13280 | | | 9.2 | |
| | 28 | 13230 | | | 9.2 | |
| | 29 | 13790 | | | 9.6 | |
| | 30 | 14070 | | | 9.8 | |
| | 31 | 19420 | 391750 | | 13.5 | |

1993 DAILY MAKEUP WATER

| MONTH | DAY | GAL/DAY | TOTAL | AVG GPD | GAL/MIN | AVG GPM |
|---|---|---|---|---|---|---|
| | 1 | 19980 | | | 13.9 | |
| | 2 | 23710 | | | 16.5 | |
| | 3 | 23970 | | | 16.6 | |
| | 4 | 23280 | | | 16.2 | |
| | 5 | 19300 | | | 13.4 | |
| | 6 | 9580 | | | 6.7 | |
| | 7 | 15810 | | | 11.0 | |
| | 8 | 20750 | | | 14.4 | |
| | 9 | 18250 | | | 12.7 | |
| | 10 | 10340 | | | 7.2 | |
| | 11 | 24770 | | | 17.2 | |
| | 12 | 14190 | | | 9.9 | |
| | 13 | 17460 | | | 12.1 | |
| | 14 | 24400 | | | 16.9 | |
| NOV | 15 | 20310 | | 15919 | 14.1 | 11.1 |
| | 16 | 16900 | | | 11.7 | |
| | 17 | 14650 | | | 10.2 | |
| | 18 | 12120 | | | 8.4 | |
| | 19 | 9870 | | | 6.9 | |
| | 20 | 13190 | | | 9.2 | |
| | 21 | 11260 | | | 7.8 | |
| | 22 | 10090 | | | 7.0 | |
| | 23 | 11110 | | | 7.7 | |
| | 24 | 14170 | | | 9.8 | |
| | 25 | 12560 | | | 8.7 | |
| | 26 | 15940 | | | 11.1 | |
| | 27 | 12950 | | | 9.0 | |
| | 28 | 12990 | | | 9.0 | |
| | 29 | 12610 | | | 8.8 | |
| | 30 | 11060 | 477570 | | 7.7 | |
| | 1 | 15770 | | | 11.0 | |
| | 2 | 9850 | | | 6.8 | |
| | 3 | 15310 | | | 10.6 | |
| | 4 | 14900 | | | 10.3 | |
| | 5 | 13840 | | | 9.6 | |
| | 6 | 12440 | | | 8.6 | |
| | 7 | 12290 | | | 8.5 | |
| | 8 | 11900 | | | 8.3 | |
| | 9 | 10640 | | | 7.4 | |
| | 10 | 15020 | | | 10.4 | |
| | 11 | 13230 | | | 9.2 | |
| | 12 | 17440 | | | 12.1 | |
| | 13 | 18190 | | | 12.6 | |
| | 14 | 17800 | | | 12.4 | |
| DEC | 15 | 24350 | | 17135 | 16.9 | 11.9 |
| | 16 | 13560 | | | 9.4 | |
| | 17 | 14870 | | | 10.3 | |
| | 18 | 14830 | | | 10.3 | |
| | 19 | 16290 | | | 11.3 | |
| | 20 | 17460 | | | 12.1 | |
| | 21 | 18540 | | | 12.9 | |
| | 22 | 16060 | | | 11.2 | |
| | 23 | 17860 | | | 12.4 | |
| | 24 | 19890 | | | 13.8 | |
| | 25 | 17650 | | | 12.3 | |
| | 26 | 22880 | | | 15.9 | |
| | 27 | 21180 | | | 14.7 | |
| | 28 | 27800 | | | 19.3 | |
| | 29 | 26840 | | | 18.6 | |
| | 30 | 21960 | | | 15.3 | |
| | 31 | 20550 | 531190 | | 14.3 | |

# A.6 ANALYSIS OF HTW AND DHW SAMPLES

# Telephone Call Confirmation

RS&H
Reynolds, Smith and Hills, Inc.
*Architectural, Engineering, Planning and Environmental Services*

**Date:** April 29, 1996

**Project Number:** 694-1331-002

**Project Name:** Fort Stewart HTW Study

**Received:** **Placed:** by W. T. Todd

**Local:** **Long Dist.:** 303-674-9897

**Conversed with:** John Tiangco

**of** Puckorius & Assoc. Water & Environmental Mgmt. Consultants

**Regarding:** Fort Stewart Boiler and HTW System Water Quality

To control general corrosion the pH and causticity should be kept high within the control range. Causticity is related to pH. Low pH is acidic and high pH is basic. Morpholine is added to the make-up water to raise the pH.

To control pitting corrosion the sulfite should be kept high within the control range. Sodium sulfite is added to the make-up water to tie up the oxygen. The high sulfite in the boiler is probably due to trying to control the HTW system sulfite with boiler feed water treatment. They recommend separate chemical feed systems. High sulfite levels do not adversely affect the system, however, it is a waste of chemicals.

The total dissolved solids (TDS) is mostly sodium which is benign. TDS is directly related to quantity of blowdown so they could reduce their blowdown by approximately 50 percent. Causticity goes up when blow down is reduced. Probably due to high alkalinity in the make-up water. When blow down is reduced the alkalinity, pH and causticity cycle up within the boiler. He thinks a de-alkalizer (similar to a water softener) would remove the bad alkalinity from the make-up water and would solve this problem. The cost would be similar to a water softener.

Water hardness is mostly calcium and some magnesium. Water softener removes most of the calcium and magnesium from make-up water. Phosphate is added to the make-up water to tie up any remaining calcium and magnesium.

**Distribution:** Fort Stewart File By: William T. Todd, PE

# BOILER SYSTEM WATER ANALYSIS PROGRAM

## FORT STEWART BUILDING 1412 BOILER 4

Sample Number . . . . XCSTEWBW
Date Sampled . . . . . 07/18/95
Date Received . . . . 08/14/95
Date Analyzed . . . . 08/17/95
Date Report Issued . 08/25/95

### Boiler Water Analysis Report

| Test Description | P&A | Plant | Control |
|---|---|---|---|
| Specific Sx Description | | | |
| Total Hardness, ppm $CaCO_3$ | <2 | | |
| Filt Ortho Phos, ppm $PO_4$ | 23 | 35 | 30 - 60 |
| Polymer, ppm | | | N/A |
| Sulfite, ppm $Na_2SO_3$ | 549 | 800 | 20 - 40 |
| P Alkalinity, ppm $CaCO_3$ | 360 | | |
| Causticity, ppm $OH^-$ | 120 | 115 | 20 - 200 |
| pH | 11.8 | 11.8 | |
| Neut Conductivity, mmhos | 2000 | 2200 | |
| Total Diss Solids, ppm | 1400 | 1540 | 3000 - 3500 |

Specific Installation Information

Post.................................... Fort Stewart
City/State/Zip............ Fort Stewart, GA 31314-5000
Phone................................ (912) 767-8931

Building Sample is From........... Central Energy PTant
Description of Sample................. BW From Boiler 4

Pretreatment.................................. Resin

Feedwater Temp (F)................................ 212
Feedwater Deoxygenation Method(s):
Mechanical.......................................
Oxygen Scavenger................... Sodium Sulfite

Boiler Type................................ Water Tube
Steam Gauge Pressure (PSIG)......................... 220
Boiler Horsepower..................................
Boiler Output (PPH)............................ 23,000
Boiler Treatment:
pH Control.......................................
Phosphate.................sodium hexametaphosphate
Dispersant.......................................

Condensate pH Control.......................morpholine

Comments

- 2P-M = 3
- 2P-M = OH
- F.D.

NOTE: REMARKS AND RECOMMENDATIONS REFLECT CONDITIONS AT TIME OF SAMPLING AND MAY NOT APPLY TO CURRENT CONDITIONS.

REMARKS:

1. Test agreement is good overall noting only a minor discrepancy for phosphate . Sulfite difference is normal since sulfite will degrade over time.

2. Results show that phosphate is below the control range. Sulfite is signficantly overdosed while causticity is within range. Blowdown is excessive based on low TDS.

continued...

RECOMMENDATIONS:

1. Reduce blowdown to allow TDS to rise into range. This can include bottom blowdown when boiler loads are light. Treatment levels will rise proportional to the rise in TDS when chemicals are fed at a constant rate so feedrates may need adjustment to keep chemical levels within their control ranges.

2. If phosphate level does not come up sufficiently by reducing blowdown, increase the phosphate dosage.

3. Reduce sulfite dosage to allow level to drop into range.

REPORT PREPARED BY: J. Tiangco

# BOILER SYSTEM WATER ANALYSIS PROGRAM
# FORT STEWART BLDG 1412 HIGH TEMP SYSTEM

Sample Number . . . . XFSTEWHT
Date Sampled . . . . 07/18/95
Date Received . . . . 08/14/95
Date Analyzed . . . . 08/17/95
Date Report Issued . 08/25/95

## High Temperature Water Analysis Report

| Test Description | P&A | Plant | Control |
|---|---|---|---|
| Specific Sx Description | | | |
| Total Hardness, ppm $CaCO_3$ | <1 | | <2 |
| Total Iron, ppm Fe | <0.05 | | |
| pH | 9.2 | 8.9 | 9.3 - 9.9 |
| Sulfite, ppm $Na_2SO_3$ | <2 | 30 | 0 - 40 |
| As Rcvd Cond, mmhos | 220 | 0-200 | |

### Specific Installation Information

Post....................................... Fort Stewart
City/State/Zip............. Fort Stewart, GA 31314-5000
Phone................................. (912) 767-8931

Building Sample is From........... Central Energy Plant
Description of Sample......... Water From Cascade Heater

System Type........................... Hot Water Boiler
Steam Gauge Pressure (PSIG)............................
Boiler Horsepower......................................
Boiler Output (BTU/HR).................................

Hot Water Temp (F)....................................
Hot Water pH Control..................................
Oxygen Scavenger........................ Sodium Sulfite

Comments

NOTE: REMARKS AND RECOMMENDATIONS REFLECT CONDITIONS AT TIME OF SAMPLING AND MAY NOT APPLY TO CURRENT CONDITIONS.

REMARKS:

1. Test agreement for pH is good. It is not clear what the plant means in reporting conductivity and TDS as 0-200. Sulfite difference is normal since sulfite will degrade over time.

2. Results shows only a trace of iron indicating good mild steel corrosion protection. The pH is within the control range.

RECOMMENDATIONS:

1. Please explain your rationale for reporting conductivity/TDS as 0-200. Other than that, no changes recommended at this time.

REPORT PREPARED BY: J. Tiangco & D.J. Robinette



Puckorius & Associates. Inc. P.O. Box 2440. Evergreen. CO 80439 303-674-9897

# BOILER SYSTEM WATER ANALYSIS PROGRAM

## FORT STEWART BLDG 1412 HIGH TEMP SYSTEM

Sample Number . . . . XFSTEWHT
Date Sampled . . . . 07/18/95
Date Received . . . . 08/14/95
Date Analyzed . . . . 08/17/95
Date Report Issued . 08/25/95

### High Temperature Water Analysis Report

| Test Description | P&A | Plant | Control |
|---|---|---|---|
| Specific Sx Description | | | |
| Total Hardness, ppm $CaCO_3$ | <1 | | <2 |
| Total Iron, ppm Fe | <0.05 | | |
| pH | 9.2 | 8.9 | 9.3 - 9.9 |
| Sulfite, ppm $Na_2SO_3$ | <2 | 30 | 0 - 40 |
| As Rcvd Cond, mmhos | 220 | 0-200 | |

Specific Installation Information

Post.................................... Fort Stewart
City/State/Zip............. Fort Stewart, GA 31314-5000
Phone................................. (912) 767-8931

Building Sample is From........... Central Energy Plant
Description of Sample......... Water From Cascade Heater

System Type........................... Hot Water Boiler
Steam Gauge Pressure (PSIG)...........................
Boiler Horsepower.....................................
Boiler Output (BTU/HR)................................

Hot Water Temp (F)....................................
Hot Water pH Control..................................
Oxygen Scavenger........................ Sodium Sulfite

Comments

NOTE: REMARKS AND RECOMMENDATIONS REFLECT CONDITIONS AT TIME OF SAMPLING AND MAY NOT APPLY TO CURRENT CONDITIONS.

REMARKS:

1. Test agreement for pH is good. It is not clear what the plant means in reporting conductivity and TDS as 0-200. Sulfite difference is normal since sulfite will degrade over time.

2. Results shows only a trace of iron indicating good mild steel corrosion protection. The pH is within the control range.

RECOMMENDATIONS:

1. Please explain your rationale for reporting conductivity/TDS as 0-200. Other than that, no changes recommended at this time.

REPORT PREPARED BY: J. Tiangco & D.J. Robinette



Puckorius & Associates, Inc. P.O. Box 2440, Evergreen, CO 80439 303-674-9897

# BOILER SYSTEM WATER ANALYSIS PROGRAM
# FORT STEWART BUILDING 1412 MAKEUP WATER

Sample Number . . . . xestewmu
Date Sampled . . . . 07/18/95
Date Received . . . . 08/14/95
Date Analyzed . . . . 08/17/95
Date Report Issued . 08/25/95

Makeup /Water Analysis Report

| Test Description | P&A | Plant | Control |
|---|---|---|---|
| Specific Sx Description | Sample not full. Clear. | | |
| Total Hardness, ppm $CaCO_3$ | <1 | 0-2 | <2 |
| As Rcvd Cond, mmhos | 245 | 150 | |
| Total Diss Solids, ppm | 170 | 105 | |
| Total Iron, ppm Fe | 0.1 | | |
| pH | 7.3 | | |
| M Alkalinity, ppm $CaCO_3$ | 121 | | |

Specific Installation Information

Post.................................... Fort Stewart
City/State/Zip.................. Fort Stewart, GA 31314
Phone................................ (   ) 767-8931

Building Sample Is From........... Central Energy Plant
Description Of Sample.................... Make-up water

Pretreatment..........................................

Comments

NOTE: REMARKS AND RECOMMENDATIONS REFLECT CONDITIONS AT TIME OF SAMPLING AND MAY NOT APPLY TO CURRENT CONDITIONS.

REMARKS:

1. Test agreement for conductivity/TDS is poor. Hardness results agree well.
2. Results show a sample that is soft and low in iron - a good quality makeup water. The M-alkalinity is naturally high and a dealkalizer would probably allow operations to run higher cycles of concentration. The payback would be reduced energy, water, and chemical consumption.

RECOMMENDATIONS:

1. Calibrate your conductivity meter and make sure that the sample cup has been thoroughly flushed before taking a reading. No other changes recommended at this time.

REPORT PREPARED BY: J. Tiangco



Puckorius & Associates, Inc. P.O. Box 2440, Evergreen, CO 80439 303-674-9897

# BOILER SYSTEM WATER ANALYSIS PROGRAM
## FORT STEWART BUILDING 1412 CONDENSATE

Sample Number . . . . XDSTEWCN
Date Sampled . . . . 07/18/95
Date Received . . . . 08/14/95
Date Analyzed . . . . 08/17/95
Date Report Issued . 08/25/95

**Specific Installation Information**

Post................................ Fort Stewart
City/State/Zip............ Fort Stewart, GA 31314
Phone.......................... ( ) 767-8931

Building Sample is From....... Central Energy Plant
Description of Sample.................. Condensate

Condensate pH Control.................. Morpholine

Comments

**Condensate Water Analysis Report**

| Test Description | P&A | Plant | Control |
|---|---|---|---|
| Specific Sx Description | Sample not full. Clear. | | |
| Total Hardness, ppm $CaCO_3$ | <2 | 0-2 | <2 |
| As Rcvd Cond, mmhos | 42 | 0-100 | <35 |
| Total Diss Solids, ppm | 29 | 0-100 | |
| Total Iron, ppm Fe | 0.1 | | |
| pH | 8.7 | 8.7 | 7.5 - 8.8 |
| M Alkalinity, ppm $CaCO_3$ | 69 | | |
| Carbon Dioxide, ppm $CO_2$ | <1 | | |

NOTE: REMARKS AND RECOMMENDATIONS REFLECT CONDITIONS AT TIME OF SAMPLING AND MAY NOT APPLY TO CURRENT CONDITIONS.

REMARKS:
1. It is not clear what the plant is trying to report for conductivity/TDS using "0-100". Test agreement for pH is good however.
2. Results show that the sample exceeds conductivity purity criteria however the iron level is acceptably low and the pH is within the control range.

RECOMMENDATIONS:
1. The small amount of contamination evidenced in the conductivity could be due to sampling error. Make sure that sample containers and sample lines are thoroughly flushed out before drawing a sample. If conductivity remains high, further troubleshooting should be undertaken.
2. No changes necessary for pH control.

REPORT PREPARED BY: J. Tiangco & D.J. Robinette

# ANALYSIS OF DHW SAMPLES

Fort Stewart Hot Water Generators
Water Analysis Data – Number of SD Above or Below AVG
Filename: WATRANAL.WQ1

| Bldg | °F | #SD | Cond | #SD | pH | #SD | PO4 | #SD | SO4 | #SD | Fe | #SD | #SD≥1 | PREMIER RANK | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AVG | 131 | | 252 | | 7.80 | | 0.19 | | 5 | | 0.03 | | | | |
| SD | 21.3 | | 16.5 | | 0.17 | | 0.08 | | 3.5 | | 0.04 | | | | |
| 206 | 80 | 0.0 | 250 | 0.1 | 8.10 | 1.8 | 0.13 | 0.0 | 2 | 0.0 | 0.27 | 6.1 | 2 | | |
| 207 | 124 | 0.0 | 236 | 1.0 | 7.80 | 0.0 | 0.22 | 0.3 | 2 | 0.0 | 0.09 | 1.6 | 2 | | |
| 208 | 113 | 0.0 | 238 | 0.9 | 8.15 | 2.1 | 0.19 | 0.0 | 1 | 0.0 | 0.03 | 0.1 | 1 | | |
| 212 | 131 | 0.0 | 227 | 1.5 | 8.10 | 1.8 | 0.21 | 0.2 | – | 0.0 | 0.02 | 0.0 | 2 | | |
| 213 | 120 | 0.0 | 229 | 1.4 | 7.75 | 0.0 | 0.13 | 0.0 | – | 0.0 | 0.01 | 0.0 | 1 | | |
| 215 | 137 | 0.3 | 227 | 1.5 | 7.80 | 0.0 | 0.13 | 0.0 | – | 0.0 | 0.04 | 0.4 | 1 | | |
| 216 | 110 | 0.0 | 227 | 1.5 | 7.85 | 0.3 | 0.07 | 0.0 | – | 0.0 | -- | 0.0 | 1 | | |
| 218 | 124 | 0.0 | 236 | 1.0 | 7.80 | 0.0 | 0.12 | 0.0 | – | 0.0 | 0.01 | 0.0 | 1 | | |
| 302 | 137 | 0.3 | 237 | 0.9 | 7.65 | 0.0 | 0.14 | 0.0 | – | 0.0 | 0.02 | 0.0 | 0 | | |
| 439 | 139 | 0.4 | 246 | 0.4 | 7.75 | 0.0 | 0.12 | 0.0 | 7 | 0.6 | 0.02 | 0.0 | 0 | ✓ | |
| 440 | 114 | 0.0 | 243 | 0.6 | 7.95 | 0.9 | 0.17 | 0.0 | 9 | 1.1 | 0.02 | 0.0 | 1 | ✓ | |
| 501 | 134 | 0.2 | 243 | 0.6 | 7.85 | 0.3 | 0.18 | 0.0 | 12 | 2.0 | 0.03 | 0.1 | 1 | ✓ | |
| 503 | 122 | 0.0 | 243 | 0.6 | 8.00 | 1.2 | 0.17 | 0.0 | 13 | 2.3 | 0.03 | 0.1 | 2 | ✓ | |
| 504 | 158 | 1.3 | 239 | 0.8 | 8.05 | 1.5 | 0.14 | 0.0 | 10 | 1.4 | 0.01 | 0.0 | 3 | ✓ | |
| 512 | 145 | 0.7 | 242 | 0.6 | 7.55 | 0.0 | 0.16 | 0.0 | 11 | 1.7 | 0.01 | 0.0 | 1 | ✓ | |
| 514 | 126 | 0.0 | 244 | 0.5 | 7.85 | 0.3 | 0.18 | 0.0 | 9 | 1.1 | 0.02 | 0.0 | 1 | ✓ | |
| 515 | 123 | 0.0 | 236 | 1.0 | 7.70 | 0.0 | 0.18 | 0.0 | 1 | 0.0 | 0.02 | 0.0 | 1 | | |
| 516 | 145 | 0.7 | 242 | 0.6 | 7.70 | 0.0 | 0.29 | 1.2 | 5 | 0.0 | -- | 0.0 | 1 | ✓ | OVERFLOW |
| 517 | 175 | 2.1 | 244 | 0.5 | 7.70 | 0.0 | 0.28 | 1.1 | 8 | 0.9 | -- | 0.0 | 2 | ✓ | |
| 518 | 183 | 2.5 | 234 | 1.1 | 7.70 | 0.0 | 0.36 | 2.1 | 9 | 1.1 | -- | 0.0 | 4 | ✓ | |
| 608 | 127 | 0.0 | 240 | 0.7 | 7.60 | 0.0 | 0.31 | 1.5 | 11 | 1.7 | 0.01 | 0.0 | 2 | ✓ | |
| 610 | 115 | 0.0 | 230 | 1.3 | 7.75 | 0.0 | 0.18 | 0.0 | 7 | 0.6 | 0.12 | 2.3 | 2 | ✓ | |
| 620 | 112 | 0.0 | 240 | 0.7 | 7.75 | 0.0 | 0.17 | 0.0 | 3 | 0.0 | -- | 0.0 | 0 | | |
| 621 | 91 | 0.0 | 244 | 0.5 | 7.85 | 0.3 | 0.16 | 0.0 | 3 | 0.0 | 0.02 | 0.0 | 0 | | |
| 622 | 85 | 0.0 | 244 | 0.5 | 7.60 | 0.0 | 0.05 | 0.0 | 2 | 0.0 | 0.02 | 0.0 | 0 | | |
| 623 | 109 | 0.0 | 238 | 0.9 | 7.65 | 0.0 | 0.09 | 0.0 | 5 | 0.0 | -- | 0.0 | 0 | | |
| 624 | 84 | 0.0 | 237 | 0.9 | 7.55 | 0.0 | 0.05 | 0.0 | – | 0.0 | -- | 0.0 | 0 | | |
| 626 | 145 | 0.7 | 275 | 0.0 | 7.45 | 0.0 | 0.08 | 0.0 | 7 | 0.6 | -- | 0.0 | 0 | | |
| 629 | 160 | 1.4 | 263 | 0.0 | 7.85 | 0.3 | 0.08 | 0.0 | 5 | 0.0 | -- | 0.0 | 1 | | |
| 630 | 117 | 0.0 | 272 | 0.0 | 7.90 | 0.6 | 0.22 | 0.3 | 6 | 0.3 | 0.02 | 0.0 | 0 | ✓ | |
| 631 | 142 | 0.5 | 267 | 0.0 | 7.75 | 0.0 | 0.15 | 0.0 | 6 | 0.3 | 0.02 | 0.0 | 0 | | |
| 632 | 160 | 1.4 | 268 | 0.0 | 7.65 | 0.0 | 0.19 | 0.0 | 6 | 0.3 | -- | 0.0 | 1 | | |
| 633 | 128 | 0.0 | 272 | 0.0 | 7.60 | 0.0 | 0.13 | 0.0 | – | 0.0 | -- | 0.0 | 0 | | |
| 635 | 140 | 0.4 | 274 | 0.0 | 8.25 | 2.6 | 0.16 | 0.0 | – | 0.0 | -- | 0.0 | 1 | | |
| 636 | 138 | 0.3 | 280 | 0.0 | 7.75 | 0.0 | 0.19 | 0.0 | – | 0.0 | -- | 0.0 | 0 | | |
| 637 | 158 | 1.3 | 278 | 0.0 | 7.75 | 0.0 | 0.23 | 0.5 | – | 0.0 | -- | 0.0 | 1 | | |
| 642 | 154 | 1.1 | 278 | 0.0 | 7.70 | 0.0 | 0.29 | 1.2 | 10 | 1.4 | -- | 0.0 | 3 | ✓ | |
| 701 | 152 | 1.0 | 272 | 0.0 | 7.75 | 0.0 | 0.12 | 0.0 | 7 | 0.6 | -- | 0.0 | 1 | ✓ | |
| 702 | 143 | 0.6 | 277 | 0.0 | 7.85 | 0.3 | 0.10 | 0.0 | 9 | 1.1 | -- | 0.0 | 1 | ✓ | |
| 708 | 131 | 0.0 | 265 | 0.0 | 7.70 | 0.0 | 0.10 | 0.0 | 6 | 0.3 | -- | 0.0 | 0 | | |
| 712 | 135 | 0.2 | 279 | 0.0 | 7.65 | 0.0 | 0.22 | 0.3 | 9 | 1.1 | -- | 0.0 | 1 | ✓ | |
| 713 | 133 | 0.1 | 271 | 0.0 | 7.70 | 0.0 | 0.27 | 1.0 | 8 | 0.9 | 0.03 | 0.1 | 1 | ✓ | |
| 714 | 137 | 0.3 | 267 | 0.0 | 7.70 | 0.0 | 0.27 | 1.0 | 7 | 0.6 | 0.01 | 0.0 | 1 | ✓ | |
| 715 | 135 | 0.2 | 263 | 0.0 | 7.80 | 0.0 | 0.36 | 2.1 | 5 | 0.0 | -- | 0.0 | 1 | ✓ | |
| 717 | 131 | 0.0 | 263 | 0.0 | 7.75 | 0.0 | 0.26 | 0.8 | 4 | 0.0 | -- | 0.0 | 0 | | |
| 718 | 124 | 0.0 | 260 | 0.0 | 7.65 | 0.0 | 0.33 | 1.7 | 2 | 0.0 | -- | 0.0 | 1 | | |
| 719 | 112 | 0.0 | 265 | 0.0 | 7.85 | 0.3 | 0.21 | 0.2 | 2 | 0.0 | -- | 0.0 | 0 | | |
| 720 | 130 | 0.0 | 281 | 0.0 | 8.25 | 2.6 | 0.29 | 1.2 | 7 | 0.6 | 0.03 | 0.1 | 2 | ✓ | |
| 726 | 158 | 1.3 | 254 | 0.0 | 8.05 | 1.5 | 0.33 | 1.7 | 7 | 0.6 | 0.06 | 0.9 | 3 | ✓ | |
| 810 | 131 | 0.0 | 248 | 0.3 | 7.90 | 0.6 | 0.27 | 1.0 | 2 | 0.0 | 0.01 | 0.0 | 1 | | |
| 1540 | 95 | 0.0 | 248 | 0.3 | 7.95 | 0.9 | 0.27 | 1.0 | 2 | 0.0 | 0.09 | 1.6 | 2 | | |
| 1720 | 148 | 0.8 | 248 | 0.3 | 7.75 | 0.0 | 0.22 | 0.3 | 5 | 0.0 | 0.02 | 0.0 | 0 | | |
| 2125 | 120 | 0.0 | 245 | 0.4 | 7.85 | 0.3 | 0.30 | 1.3 | – | 0.0 | 0.02 | 0.0 | 1 | | |

PREMIER WATER & ENERGY TECHNOLOGY, INC.

| | | Reynolds, Smith & Hills, Inc. | | | | | |
|---|---|---|---|---|---|---|---|
| | | Potable Hot Water - Ft. Stewart, Ga. | | | | | |
| | Sample | | | | | | |
| Location | Date | Conductivity | pH | PO4 | SO4 | Fe | |
| | | | | | | | |
| HTHW | 10/4/95 | 185 | 9.05 | 2.65 | 20 | 0.09 | |
| 206 | 10/4/95 | 250 | 8.10 | 0.13 | 2 | 0.27 | |
| 207 | 10/4/95 | 236 | 7.80 | 0.22 | 2 | 0.09 | |
| 208 | 10/4/95 | 238 | 8.15 | 0.19 | 1 | 0.03 | |
| 212 | 10/4/95 | 227 | 8.10 | 0.21 | <1 | 0.02 | |
| 213 | 10/4/95 | 229 | 7.75 | 0.13 | <1 | 0.01 | |
| 215 | 10/4/95 | 227 | 7.80 | 0.13 | <1 | 0.04 | |
| 216 | 10/4/95 | 227 | 7.85 | 0.07 | <1 | <.01 | |
| 218 | 10/4/95 | 236 | 7.80 | 0.12 | <1 | 0.01 | |
| 302 | 10/4/95 | 237 | 7.65 | 0.14 | <1 | 0.02 | |
| 439 | 10/3/95 | 246 | 7.75 | 0.12 | 7 | 0.02 | * |
| 440 | 10/3/95 | 243 | 7.95 | 0.17 | 9 | 0.02 | * |
| 501 | 10/3/95 | 243 | 7.85 | 0.18 | 12 | 0.03 | * |
| 503 | 10/3/95 | 243 | 8.00 | 0.17 | 13 | 0.03 | * |
| 504 | 10/3/95 | 239 | 8.05 | 0.14 | 10 | 0.01 | * |
| 512 | 10/3/95 | 242 | 7.55 | 0.16 | 11 | 0.01 | * |
| 514 | 10/2/95 | 244 | 7.85 | 0.18 | 9 | 0.02 | * |
| 515 | 10/2/95 | 236 | 7.70 | 0.18 | 1 | 0.02 | |
| 516 | 10/2/95 | 242 | 7.70 | 0.29 | 5 | <.01 | * |
| 517 | 10/2/95 | 244 | 7.70 | 0.28 | 8 | <.01 | * |
| 518 | 10/2/95 | 234 | 7.70 | 0.36 | 9 | <.01 | * |
| 608 | 10/3/95 | 240 | 7.60 | 0.31 | 11 | 0.01 | * |
| 610 | 10/4/95 | 230 | 7.75 | 0.18 | 7 | 0.12 | * |
| 620 | 10/3/95 | 240 | 7.75 | 0.17 | 3 | <.01 | |
| 621 | 10/3/95 | 244 | 7.85 | 0.16 | 3 | 0.02 | |
| 622 | 10/3/95 | 244 | 7.60 | 0.05 | 2 | 0.02 | |
| 623 | 10/3/95 | 238 | 7.65 | 0.09 | 5 | <.01 | |
| 624 | 10/3/95 | 237 | 7.55 | 0.05 | <1 | <.01 | |
| 626 | 10/3/95 | 275 | 7.45 | 0.08 | 7 | <.01 | |
| 629 | 10/3/95 | 263 | 7.85 | 0.08 | 5 | <.01 | |
| 630 | 10/3/95 | 272 | 7.90 | 0.22 | 6 | 0.02 | * |
| 631 | 10/3/95 | 267 | 7.75 | 0.15 | 6 | 0.02 | |
| 632 | 10/3/95 | 268 | 7.65 | 0.19 | 6 | <.01 | |
| 633 | 10/3/95 | 272 | 7.60 | 0.13 | <1 | <.01 | |
| 635 | 10/3/95 | 274 | 8.25 | 0.16 | <1 | <.01 | |



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T.M.

# PREMIER WATER & ENERGY TECHNOLOGY, INC.

| | | Reynolds, Smith & Hills, Inc. | | | | | |
|---|---|---|---|---|---|---|---|
| | | Potable Hot Water - Ft. Stewart, Ga. | | | | | |
| | Sample | | | | | | |
| Location | Date | Conductivity | pH | PO4 | SO4 | Fe | |
| | | | | | | | |
| 636 | 10/3/95 | 280 | 7.75 | 0.19 | <1 | <.01 | |
| 637 | 10/3/95 | 278 | 7.75 | 0.23 | <1 | <.01 | |
| 642 | 10/3/95 | 278 | 7.70 | 0.29 | 10 | <.01 | * |
| 701 | 10/3/95 | 272 | 7.75 | 0.12 | 7 | <.01 | * |
| 702 | 10/3/95 | 277 | 7.85 | 0.10 | 9 | <.01 | * |
| 708 | 10/3/95 | 265 | 7.70 | 0.10 | 6 | <.01 | |
| 712 | 10/3/95 | 279 | 7.65 | 0.22 | 9 | <.01 | * |
| 713 | 10/3/95 | 271 | 7.70 | 0.27 | 8 | 0.03 | * |
| 714 | 10/3/95 | 267 | 7.70 | 0.27 | 7 | 0.01 | * |
| 715 | 10/3/95 | 263 | 7.80 | 0.36 | 5 | <.01 | * |
| 717 | 10/3/95 | 263 | 7.75 | 0.26 | 4 | <.01 | |
| 718 | 10/3/95 | 260 | 7.65 | 0.33 | 2 | <.01 | |
| 719 | 10/3/95 | 265 | 7.85 | 0.21 | 2 | <.01 | |
| 720 | 10/3/95 | 281 | 8.25 | 0.29 | 7 | 0.03 | * |
| 726 | 10/3/95 | 254 | 8.05 | 0.33 | 7 | 0.06 | * |
| 810 | 10/3/95 | 248 | 7.90 | 0.27 | 2 | 0.01 | |
| 1540 | 10/3/95 | 248 | 7.95 | 0.27 | 2 | 0.09 | |
| 1720 | 10/3/95 | 248 | 7.75 | 0.22 | 5 | 0.02 | |
| 2125 | 10/3/95 | 245 | 7.85 | 0.30 | <1 | 0.02 | |
| 2125 P | 10/3/95 | 241 | 7.85 | 0.04 | <1 | 0.01 | |

PO4 = Phosphate
SO4 = Sulfate
Fe = Iron

The samples that are marked in the far right column with an asterisk indicate sufficient differences in readings to suspect the possibility of leakage in these units.



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Fort Stewart Hot Water Generators
Water Analysis Data – Sorted by Component & Ranked
Filename: WATRANAL.WQ1

| Bldg | °F | Rk | Bldg | Cond | Rk | Bldg | pH | Rk | Bldg | PO4 | Rk | Bldg | SO4 | Rk | Bldg | Fe | Rk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 518 | 183 | 1 | 212 | 227 | 1 | 635 | 8.25 | 1 | 715 | 0.36 | 1 | 503 | 13 | 1 | 206 | 0.27 | 1 |
| 517 | 175 | 2 | 215 | 227 | 1 | 720 | 8.25 | 1 | 518 | 0.36 | 1 | 501 | 12 | 2 | 610 | 0.12 | 2 |
| 629 | 160 | 3 | 216 | 227 | 1 | 208 | 8.15 | 2 | 718 | 0.33 | 2 | 608 | 11 | 3 | 1540 | 0.09 | 3 |
| 632 | 160 | 3 | 213 | 229 | 2 | 206 | 8.10 | 3 | 726 | 0.33 | 2 | 512 | 11 | 3 | 207 | 0.09 | 3 |
| 504 | 158 | 4 | 610 | 230 | 3 | 212 | 8.10 | 3 | 608 | 0.31 | 3 | 504 | 10 | 4 | 726 | 0.06 | 4 |
| 637 | 158 | 4 | 518 | 234 | 4 | 726 | 8.05 | 4 | 2125 | 0.30 | 4 | 642 | 10 | 4 | 215 | 0.04 | 5 |
| 726 | 158 | 4 | 218 | 236 | 5 | 504 | 8.05 | 4 | 642 | 0.29 | 5 | 702 | 9 | 5 | 720 | 0.03 | 6 |
| 642 | 154 | 5 | 207 | 236 | 5 | 503 | 8.00 | 5 | 720 | 0.29 | 5 | 440 | 9 | 5 | 208 | 0.03 | 6 |
| 701 | 152 | 6 | 515 | 236 | 5 | 440 | 7.95 | 6 | 516 | 0.29 | 5 | 518 | 9 | 5 | 501 | 0.03 | 6 |
| 1720 | 148 | 7 | 624 | 237 | 6 | 1540 | 7.95 | 6 | 517 | 0.28 | 6 | 514 | 9 | 5 | 713 | 0.03 | 6 |
| 512 | 145 | 8 | 302 | 237 | 6 | 810 | 7.90 | 7 | 1540 | 0.27 | 7 | 712 | 9 | 5 | 503 | 0.03 | 6 |
| 516 | 145 | 8 | 623 | 238 | 7 | 630 | 7.90 | 7 | 810 | 0.27 | 7 | 713 | 8 | 6 | 515 | 0.02 | 7 |
| 626 | 145 | 8 | 208 | 238 | 7 | 621 | 7.85 | 8 | 713 | 0.27 | 7 | 517 | 8 | 6 | 1720 | 0.02 | 7 |
| 702 | 143 | 9 | 504 | 239 | 8 | 719 | 7.85 | 8 | 714 | 0.27 | 7 | 626 | 7 | 7 | 621 | 0.02 | 7 |
| 631 | 142 | 10 | 620 | 240 | 9 | 629 | 7.85 | 8 | 717 | 0.26 | 8 | 610 | 7 | 7 | 622 | 0.02 | 7 |
| 635 | 140 | 11 | 608 | 240 | 9 | 702 | 7.85 | 8 | 637 | 0.23 | 9 | 714 | 7 | 7 | 514 | 0.02 | 7 |
| 439 | 139 | 12 | 516 | 242 | 10 | 216 | 7.85 | 8 | 1720 | 0.22 | 10 | 720 | 7 | 7 | 302 | 0.02 | 7 |
| 636 | 138 | 13 | 512 | 242 | 10 | 514 | 7.85 | 8 | 207 | 0.22 | 10 | 439 | 7 | 7 | 2125 | 0.02 | 7 |
| 215 | 137 | 14 | 440 | 243 | 11 | 2125 | 7.85 | 8 | 630 | 0.22 | 10 | 726 | 7 | 7 | 212 | 0.02 | 7 |
| 302 | 137 | 14 | 503 | 243 | 11 | 501 | 7.85 | 8 | 712 | 0.22 | 10 | 701 | 7 | 7 | 439 | 0.02 | 7 |
| 714 | 137 | 14 | 501 | 243 | 11 | 207 | 7.80 | 9 | 212 | 0.21 | 11 | 631 | 6 | 8 | 631 | 0.02 | 7 |
| 712 | 135 | 15 | 622 | 244 | 12 | 715 | 7.80 | 9 | 719 | 0.21 | 11 | 708 | 6 | 8 | 630 | 0.02 | 7 |
| 715 | 135 | 15 | 621 | 244 | 12 | 215 | 7.80 | 9 | 208 | 0.19 | 12 | 630 | 6 | 8 | 440 | 0.02 | 7 |
| 501 | 134 | 16 | 514 | 244 | 12 | 218 | 7.80 | 9 | 636 | 0.19 | 12 | 632 | 6 | 8 | 714 | 0.01 | 8 |
| 713 | 133 | 17 | 517 | 244 | 12 | 636 | 7.75 | 10 | 632 | 0.19 | 12 | 629 | 5 | 9 | 504 | 0.01 | 8 |
| 212 | 131 | 18 | 2125 | 245 | 13 | 717 | 7.75 | 10 | 514 | 0.18 | 13 | 623 | 5 | 9 | 512 | 0.01 | 8 |
| 708 | 131 | 18 | 439 | 246 | 14 | 631 | 7.75 | 10 | 501 | 0.18 | 13 | 516 | 5 | 9 | 213 | 0.01 | 8 |
| 717 | 131 | 18 | 1540 | 248 | 15 | 701 | 7.75 | 10 | 515 | 0.18 | 13 | 1720 | 5 | 9 | 218 | 0.01 | 8 |
| 810 | 131 | 18 | 810 | 248 | 15 | 213 | 7.75 | 10 | 610 | 0.18 | 13 | 715 | 5 | 9 | 810 | 0.01 | 8 |
| 720 | 130 | 19 | 1720 | 248 | 15 | 637 | 7.75 | 10 | 440 | 0.17 | 14 | 717 | 4 | 10 | 608 | 0.01 | 8 |
| 633 | 128 | 20 | 206 | 250 | 16 | 1720 | 7.75 | 10 | 620 | 0.17 | 14 | 621 | 3 | 11 | 712 | -- | 9 |
| 608 | 127 | 21 | 726 | 254 | 17 | 439 | 7.75 | 10 | 503 | 0.17 | 14 | 620 | 3 | 11 | 708 | -- | 9 |
| 514 | 126 | 22 | 718 | 260 | 18 | 620 | 7.75 | 10 | 635 | 0.16 | 15 | 207 | 2 | 12 | 702 | -- | 9 |
| 207 | 124 | 23 | 717 | 263 | 19 | 610 | 7.75 | 10 | 621 | 0.16 | 15 | 1540 | 2 | 12 | 717 | -- | 9 |
| 218 | 124 | 23 | 715 | 263 | 19 | 714 | 7.70 | 11 | 512 | 0.16 | 15 | 810 | 2 | 12 | 719 | -- | 9 |
| 718 | 124 | 23 | 629 | 263 | 19 | 713 | 7.70 | 11 | 631 | 0.15 | 16 | 206 | 2 | 12 | 715 | -- | 9 |
| 515 | 123 | 24 | 708 | 265 | 20 | 708 | 7.70 | 11 | 302 | 0.14 | 17 | 622 | 2 | 12 | 718 | -- | 9 |
| 503 | 122 | 25 | 719 | 265 | 20 | 515 | 7.70 | 11 | 504 | 0.14 | 17 | 718 | 2 | 12 | 701 | -- | 9 |
| 213 | 120 | 26 | 631 | 267 | 21 | 517 | 7.70 | 11 | 215 | 0.13 | 18 | 719 | 2 | 12 | 620 | -- | 9 |
| 2125 | 120 | 26 | 714 | 267 | 21 | 518 | 7.70 | 11 | 213 | 0.13 | 18 | 515 | 1 | 13 | 623 | -- | 9 |
| 630 | 117 | 27 | 632 | 268 | 22 | 642 | 7.70 | 11 | 633 | 0.13 | 18 | 208 | 1 | 13 | 624 | -- | 9 |
| 610 | 115 | 28 | 713 | 271 | 23 | 516 | 7.70 | 11 | 206 | 0.13 | 18 | 2125 | - | 14 | 518 | -- | 9 |
| 440 | 114 | 29 | 633 | 272 | 24 | 718 | 7.65 | 12 | 218 | 0.12 | 19 | 216 | - | 14 | 216 | -- | 9 |
| 208 | 113 | 30 | 630 | 272 | 24 | 302 | 7.65 | 12 | 439 | 0.12 | 19 | 218 | - | 14 | 516 | -- | 9 |
| 620 | 112 | 31 | 701 | 272 | 24 | 623 | 7.65 | 12 | 701 | 0.12 | 19 | 215 | - | 14 | 517 | -- | 9 |
| 719 | 112 | 31 | 635 | 274 | 25 | 712 | 7.65 | 12 | 702 | 0.10 | 20 | 212 | - | 14 | 626 | -- | 9 |
| 216 | 110 | 32 | 626 | 275 | 26 | 632 | 7.65 | 12 | 708 | 0.10 | 20 | 213 | - | 14 | 636 | -- | 9 |
| 623 | 109 | 33 | 702 | 277 | 27 | 608 | 7.60 | 13 | 623 | 0.09 | 21 | 302 | - | 14 | 637 | -- | 9 |
| 1540 | 95 | 34 | 642 | 278 | 28 | 622 | 7.60 | 13 | 626 | 0.08 | 22 | 636 | - | 14 | 642 | -- | 9 |
| 621 | 91 | 35 | 637 | 278 | 28 | 633 | 7.60 | 13 | 629 | 0.08 | 22 | 637 | - | 14 | 635 | -- | 9 |
| 622 | 85 | 36 | 712 | 279 | 29 | 512 | 7.55 | 14 | 216 | 0.07 | 23 | 635 | - | 14 | 629 | -- | 9 |
| 624 | 84 | 37 | 636 | 280 | 30 | 624 | 7.55 | 14 | 622 | 0.05 | 24 | 624 | - | 14 | 632 | -- | 9 |
| 206 | 80 | 38 | 720 | 281 | 31 | 626 | 7.45 | 15 | 624 | 0.05 | 24 | 633 | - | 14 | 633 | -- | 9 |

Fort Stewart Hot Water Generators
Water Analysis Data - Sorted by Bldg Number
Filename: WATRANAL.WQ1

| Bldg | °F | Cond | pH | PO4 | SO4 | Fe |
|---|---|---|---|---|---|---|
| PW | | 241 | 7.85 | 0.04 | 1 | 0.01 |
| HTHW | | 185 | 9.05 | 2.65 | 20 | 0.09 |
| BLDG | °F | COND | PH | PO4 | SO4 | FE |
| 206 | 80 | 250 | 8.10 | 0.13 | 2 | 0.27 |
| 207 | 124 | 236 | 7.80 | 0.22 | 2 | 0.09 |
| 208 | 113 | 238 | 8.15 | 0.19 | 1 | 0.03 |
| 212 | 131 | 227 | 8.10 | 0.21 | 1 | 0.02 |
| 213 | 120 | 229 | 7.75 | 0.13 | 1 | 0.01 |
| 215 | 137 | 227 | 7.80 | 0.13 | 1 | 0.04 |
| 216 | 110 | 227 | 7.85 | 0.07 | 1 | 0.01 |
| 218 | 124 | 236 | 7.80 | 0.12 | 1 | 0.01 |
| 302 | 137 | 237 | 7.65 | 0.14 | 1 | 0.02 |
| 439 | 139 | 246 | 7.75 | 0.12 | 7 | 0.02 |
| 440 | 114 | 243 | 7.95 | 0.17 | 9 | 0.02 |
| 501 | 134 | 243 | 7.85 | 0.18 | 12 | 0.03 |
| 503 | 122 | 243 | 8.00 | 0.17 | 13 | 0.03 |
| 504 | 158 | 239 | 8.05 | 0.14 | 10 | 0.01 |
| 512 | 145 | 242 | 7.55 | 0.16 | 11 | 0.01 |
| 514 | 126 | 244 | 7.85 | 0.18 | 9 | 0.02 |
| 515 | 123 | 236 | 7.70 | 0.18 | 1 | 0.02 |
| 516 | 145 | 242 | 7.70 | 0.29 | 5 | 0.01 |
| 517 | 175 | 244 | 7.70 | 0.28 | 8 | 0.01 |
| 518 | 183 | 234 | 7.70 | 0.36 | 9 | 0.01 |
| 608 | 127 | 240 | 7.60 | 0.31 | 11 | 0.01 |
| 610 | 115 | 230 | 7.75 | 0.18 | 7 | 0.12 |
| 620 | 112 | 240 | 7.75 | 0.17 | 3 | 0.01 |
| 621 | 91 | 244 | 7.85 | 0.16 | 3 | 0.02 |
| 622 | 85 | 244 | 7.60 | 0.05 | 2 | 0.02 |
| 623 | 109 | 238 | 7.65 | 0.09 | 5 | 0.01 |
| 624 | 84 | 237 | 7.55 | 0.05 | 1 | 0.01 |
| 626 | 145 | 275 | 7.45 | 0.08 | 7 | 0.01 |
| 629 | 160 | 263 | 7.85 | 0.08 | 5 | 0.01 |
| 630 | 117 | 272 | 7.90 | 0.22 | 6 | 0.02 |
| 631 | 142 | 267 | 7.75 | 0.15 | 6 | 0.02 |
| 632 | 160 | 268 | 7.65 | 0.19 | 6 | 0.01 |
| 633 | 128 | 272 | 7.60 | 0.13 | 1 | 0.01 |
| 635 | 140 | 274 | 8.25 | 0.16 | 1 | 0.01 |
| 636 | 138 | 280 | 7.75 | 0.19 | 1 | 0.01 |
| 637 | 158 | 278 | 7.75 | 0.23 | 1 | 0.01 |
| 642 | 154 | 278 | 7.70 | 0.29 | 10 | 0.01 |
| 701 | 152 | 272 | 7.75 | 0.12 | 7 | 0.01 |
| 702 | 143 | 277 | 7.85 | 0.10 | 9 | 0.01 |
| 708 | 131 | 265 | 7.70 | 0.10 | 6 | 0.01 |
| 712 | 135 | 279 | 7.65 | 0.22 | 9 | 0.01 |
| 713 | 133 | 271 | 7.70 | 0.27 | 8 | 0.03 |
| 714 | 137 | 267 | 7.70 | 0.27 | 7 | 0.01 |
| 715 | 135 | 263 | 7.80 | 0.36 | 5 | 0.01 |
| 717 | 131 | 263 | 7.75 | 0.26 | 4 | 0.01 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 718 | 124 | 260 | 7.65 | 0.33 | 2 | 0.01 |
| 719 | 112 | 265 | 7.85 | 0.21 | 2 | 0.01 |
| 720 | 130 | 281 | 8.25 | 0.29 | 7 | 0.03 |
| 726 | 158 | 254 | 8.05 | 0.33 | 7 | 0.06 |
| 810 | 131 | 248 | 7.90 | 0.27 | 2 | 0.01 |
| 1540 | 95 | 248 | 7.95 | 0.27 | 2 | 0.09 |
| 1720 | 148 | 248 | 7.75 | 0.22 | 5 | 0.02 |
| 2125 | 120 | 245 | 7.85 | 0.30 | 1 | 0.02 |

| | °F | COND | PH | PO4 | SO4 | FE |
|---|---|---|---|---|---|---|
| MIN | 80.0 | 227.0 | 7.5 | 0.05 | 1.0 | 0.01 |
| AVG | 130.6 | 252.2 | 7.8 | 0.19 | 5.0 | 0.03 |
| MAX | 183.0 | 281.0 | 8.3 | 0.36 | 13.0 | 0.27 |
| P-SD | 21.3 | 16.5 | 0.17 | 0.08 | 3.5 | 0.04 |
| P-VAR | 454 | 273 | 0.03 | 0.01 | 12 | 0.002 |
| AVG ± SD | 151.9 | 235.7 | 8.0 | 0.27 | 8.5 | 0.07 |

**RS&H**®

**Telephone Call Confirmation**

268-1152

Project Number 694-1331-002

Local ___ L.D. ___ Placed ___ Rec'd ___ Date 9-18-95

Conversed with Gale Fillinger Of Premier Water and Energy Tech.

Regarding Fort Stewart HTW Analysis

Gale is familiar with the HTW treatment at Fort Stewart. He thinks they could detect differences in phosphate, conductivity and ph if the heat exchangers were leaking. We should also take 3-5 samples of potable water from different areas of the Fort, and two samples of the HTW. Samples from barracks should be taken in the afternoon. Cost of analysis is about $25 each and it will take 2-3 days to do 100+ samples and prepare a report. They will provide the sample bottles (~1 pint each) with labels we can mark on. He would like about 1 week notice prior to the site visit to make sure they have enough sample bottles on-hand. Their facility is located near Sherrod Vans off Greenland Road.

Distribution:

**RS&H**®
## Telephone Call Confirmation

Project Number 694-1331-002

Local ___ L.D. ___ Placed ___ Rec'd ___ Date 9-14-95

Conversed with Tom Brandvold Of Premier Water & Energy Tech. 268-1152

Regarding Fort Stewart Water Analysis

Premier currently treats and tests the condenser water for the CEP at Fort Stewart. Tom thinks they could detect HTW in the domestic hot water by lab analysis. Gale Fillinger has the account for Fort Stewart.

Tom will meet with Gale and try to figure out the best method to accomplish our task and they will call me back next week.

Distribution:

# A.7 SUBMITTAL REVIEW COMMENTS AND REVIEW ACTIONS

INTERIM

| PROJECT REVIEW COMMENTS | Date: 12 APR 96 | Page 1 of 1 |
|---|---|---|

TO: MR. CHET SCRATZMEIER
CHIEF, PROJ/PROJ MGMT & OPS DIVISION

FROM: (Section) DPW, EP&S DIVISION
(Reviewer) POWELL

| Project | Year | Line Item No. |
|---|---|---|
| Project: LIMITED ENERGY STUDY, HIGH TEMPERATURE AND CHILLED WATER DISTRIBUTION SYSTEMS<br>Location: FORT STEWART AND HUNTER AAF, GA | FY-96 | DACA01-94-D-0038<br>#694-1331-002 |

Type of Action (Check Appropriate Boxes)
[ ] Preliminary [ ] Final [X] INTERIM
[ ] Paving & Grading [ ] Architectural [ ] Structural
[X] Mechanical [ ] Electrical [ ] Sanitary

| Item No. | Drawing No. or Paragraph No | COMMENTS | REVIEW ACTION |
|---|---|---|---|
| 1. | GENERAL | RECOMMEND THAT THE PRE-FINAL REPORT CONTAIN A DISCUSSION AND RECOMMENDATIONS ON WATER TREATMENT AND CATHODIC PROTECTION, SACRIFICIAL ANODE, OR OTHER CORROSION AND SCALE PREVENTION/PROTECTION PRACTICES THAT COULD BE IMPLEMENTED OR THAT NEED CHANGING AT FT. STEWART AND HUNTER AAF TO INCREASE THE LIFE OF THE DISTR. SYSTEMS. | CONCUR. DISCUSSION OF CURRENT PRACTICES AND CATHODIC PROTECTION WERE ADDED TO SECTION 4.3. |
| 2. | VOLUME 1 PARA. 5.2 / 1 C.E.P. | THE RECOMMENDATION SHOULD ADDRESS ANY NEGATIVE EFFECTS OR REDUCTION IN PLANT CAPABILITY BY REDUCING THE SYSTEM PRESSURE AS RECOMMENDED. | CONCUR. DISCUSSION WAS ADDED TO THE ECO-12 RECOMMENDATIONS. |
| 3. | VOLUME 1 PARA. 5.2 C.E.P. | PREVIOUS STUDIES HAVE MENTIONED DEAERATOR PROBLEMS THAT COULD CAUSE CORROSION TO ACCELERATE IN THE HTHW DISTRIBUTION SYSTEM. THIS SHOULD BE INVESTIGATED TO DETERMINE IF THE PROBLEMS HAVE BEEN CORRECTED, AND IF NOT, RECOMMENDATIONS SHOULD BE ADDED TO THE PRE-FINAL REPORT. | NO ACTION REQUIRED. THE DEAERATOR PROBLEMS HAVE BEEN CORRECTED. |
| 4. | VOLUME 1 PARA. 5.2 VALVE PITS | TREES AND SHRUBS HAVE BEEN OBSERVED GROWING IN VALVE PITS IN THE PAST. REMOVAL OF THIS DESTRUCTIVE GROWTH AT AN EARLY STAGE, TO PREVENT DAMAGE TO THE PITS AND PIPING SHOULD BE INCLUDED IN THE FINAL O&M RECOMMENDATIONS. | CONCUR. COMMENT AND LOCATION OF VALVE PIT WILL BE ADDED TO THE O&M RECOMMEND. |
| 5. | VOLUME 3 SURVEY FORMS | RECOMMEND THAT A COPY OF THESE FIELD NOTES BE GIVEN TO THE MECHANICAL SHOPS. A LOT OF LEG WORK HAS BEEN DONE IN THIS INVESTIGATION, AND THE MECHANICAL ROOMS WITH THE LARGEST LEAKS ARE IDENTIFIED AND CAN BE REPAIRED. | CONCUR, A SUMMARY OF THE VALVE PIT SURVEY AND MECH. EQUIPMENT ROOM SURVEY WILL BE ADDED TO VOLUME 3. |

AFZP FORM 193

RS&H
Reynolds, Smith and Hills, Inc.
*Architectural, Engineering, Planning and Environmental Services*

# Response to Review Comments

**Date:** May 28, 1996

**Reviewer:** Chet Scratzmeier (by Powell)
Fort Stewart DPW, EP&S Division

**Response by:** William T. Todd, PE

**Subject:** Interim Submittal
Limited Energy Study, HTW Distribution System, Fort Stewart
DACA01-94-D-0038, RSH #694-1331-002

| Number | Dwg/Pg/Par. | Response | Review Action Comments |
|---|---|---|---|
| 1 | General | Concur | A discussion of cathodic protection and current water treatment practices will be added as Section 4.3. |
| 2 | Vol. 1, Par 5.2 | Concur | A discussion of operation at reduced pressures will be added to the ECO-12 Recommendations in Section 4.4. |
| 3 | Vol. 1, Par 5.2 | Concur | No action required. The problems with the deaerator have been corrected. |
| 4 | Vol. 1, Par 5.2 | Concur | An O&M recommendation with the valve pit number and location will be added to Section 5.2. |
| 5 | Vol. 3, Forms | Concur | A summary of findings for the valve pit survey and the mechanical equipment room survey will be added to Appendix Sections B.1 and B.2, respectively. |

CC: C. Warren
File

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CESAS-EN-DM Date: 15 APR 1996 INTERIM

MEMORANDUM THRU EN-D/DESIGN BRANCH

FOR EN-PM

SUBJECT: HTW/CHW DISTR STUDY, FY-96, LI 6029000, FORT STEWART, GA,.

| | | | |
|---|---|---|---|
| 1. | | Enclosed are this sections A/E specific instructions with manday estimate. | |
| 2. | | a. Man-day estimate (mandatory for all change orders) is:<br>[ ] Professional<br>[ ] Sub-professional<br>[ ] Clerical<br>*b. Number of sheets of new drawings:* | |
| 3. | | *The A/E's specifications have been reviewed and*<br>[ ] are satisfactory subject to enclosed comments<br>[ ] A/E should visit the District office for special instruction prior to preparation of specifications. | |
| 4. | | *Revised A/E instructions are enclosed.* | |
| 5. | X | *The A/E's*<br>[ ] Concept submittal<br>[ ] % preliminary<br>Corrected<br>[ ] Final submittal<br>[XX] Study<br>[ ] Cost Estimate<br>[ ] FP Eng Credentials | [ ] is approved for continuation of design subject to enclosed comments.<br>[ ] shall be revised in accordance with enclosed comments & *RESUBMITTED* prior to preceding with design.<br>SECTION CHIEF: ________<br>[XX] is satisfactory. CONCUR. NO ACTION REQUIRED.<br>[ ] shall be revised in accordance with enclosed comments. |
| 6. | | *The design of the project thus far* [ ] is [ ] is not *satisfactory for A/E payment.* | |
| 7. | | *The enclosed annotated review comments have been reviewed and*<br>[ ] the annotation added by the A/E are satisfactory<br>[ ] the annotations are satisfactory except as indicated by the enclosed additional comments. | |
| 8. | | *The comments prepared by* are appropriate *for mailing to the A/E.* | |
| 9. | | *The comments prepared by* are appropriate except where indicated. *Additional comments or clarifications are enclosed.* | |
| 10. | | *The enclosed meeting notification is acknowledged.*<br>[ ] No one from this section will attend.<br>[ ] The following team member will attend ________ | |
| 11. | | *This project's Arms Room design* [ ] is satisfactory [ ] does not have an Arms Rm or Vault. | |
| 12. | X | *EXCELLENT SUBMITTAL*<br>CONCUR. NO ACTION REQUIRED. | |

Prepared by: WALT HOHNE

SAS FL 207 (April 89)

INTERIM

| MOBILE DISTRICT PROJECT REVIEW COMMENTS: | | DATE: April 10, 1996 | Page 1 of 1 |
|---|---|---|---|
| TO: U. S. Army Corps of Engineers Savannah District Savannah, GA. | | FROM: Robert S. Woodruff, CESAM-EN-DM Phone: (334) 694-6074 FAX: (334) 690-2424 | |
| PROJECT/FY: Limited Energy Study High Temperature and Chilled Water Distribution Systems | | | |
| LOCATION: Fort Stewart and Hunter AAF, GA. | | | |
| TYPE REVIEW: Interim Submittal | | | |

| NO. | Page/Par | COMMENT | Response to Comment |
|---|---|---|---|
| 1. | P. 1-1 | The conclusions of the previous report which eliminated the High Temperature water system at Hunter AAF and both chilled water systems from this study should be restated here. As presented the reader is left wondering what happened to that part of the study because Appendix A.10 does not exist in this report. | CONCUR. APPENDIX A.10 WILL BE INC. IN THE PRE-FINAL SUBMITTAL. |
| 2. | P. 1-2 | The evaluation of E.C.O. 8 ( Repair underground HTW system leaks) is dependent on the completion of the underground piping leak survey. The corroborating evidence that 40 % of the system leaks are in the underground piping is dependent on the completion of the underground piping leak survey. The Scope of Work ( Para. 6.1) requires that all ECO's be evaluated in the interim report.<br>Because of the importance of this survey and the resulting work related to it the interim report can not be considered complete without it.<br>The A/E should resubmit the interim report when this work is completed. | CONCUR. COPY WAS PROVIDED AT THE REVIEW MEETING. RESUBMITTAL IS NOT REQUIRED. ECO 8 WILL BE INCLUDED IN PRE-FINAL RPT. |
| 3. | P. 4-11 Para. 5 | This paragraph states that 40% of the high temperature water system leak losses are in the underground portion of the piping. If 40% of the losses were caused by one or two leaks wouldn't they be worth repairing ? | CONCUR. THIS WAS ADDRESSED BY ECO 8 WILL CLARIFY TEXT IN PREFINAL REPORT. |
| 4. | P. 4-36 Para. 4 | Is there any basis for concluding that half of the underground piping insulation is deteriorated ? | CONCUR. Basis for THIS VALUE WILL BE ADDED TO TEXT. |

RS&H
Reynolds, Smith and Hills, Inc.
*Architectural, Engineering, Planning and Environmental Services*

# Response to Review Comments

**Date:** May 28, 1996

**Reviewer:** Robert S. Woodruff, CESAM-EN-DM
U. S. Army COE, Savannah District

**Response by:** William T. Todd, PE

**Subject:** Interim Submittal
Limited Energy Study, HTW Distribution System, Fort Stewart
DACA01-94-D-0038, RSH #694-1331-002

| Number | Dwg/Pg/Par. | Response | Review Action Comments |
|---|---|---|---|
| 1 | Pg 1-1 | Concur | Appendix A.10 will be included in the Pre-final Submittal. |
| 2 | Pg 1-2 | Concur | Resubmittal is not required. A copy of the ECO-8 evaluation and recommendations was provided at the review meeting and will be included in the Pre-final submittal. |
| 3 | Pg 4-11, Par 5 | Concur | The analysis for ECO-8 indicates there are many small leaks. The text in the Pre-final submittal will be modified to clearly indicate the number and quantity of leaks. |
| 4 | Pg 4-36, Par 4 | Concur | The assumption was based on our field observations of the valve pits and conduit vents. This will be added to the text. |

CC: C. Warren
File

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INTERIM

CECPW-EM 11 April 1996

MEMORANDUM FOR Commander, U.S. Army Forces Command,
ATTN: AFPI-ENO (Mr. Naresh Kapur)
Fort McPherson, GA 30330-6000

SUBJECT: Review of Interim Report on Fort Stewart's High Temperature and Chilled Water Distribution System

1. Reference 1 April 1996 phone call from Naresh Kapur, FORSCOM, to Dennis Vevang, CECPW-EM, requesting review of Fort Stewart's interim report. NO ACTION REQUIRED.

2. On 2 April received the three volumes of the interim report "LIMITED ENERGY STUDY HIGH TEMPERATURE AND CHILLED WATER DISTRIBUTION SYSTEMS FOR STEWART AND HUNTER AAF, GEORGIA" prepared by Reynolds, Smith and Hills, Inc. of Jacksonville, Florida. NO ACTION REQUIRED.

3. SCOPE OF WORK: NO ACTION REQUIRED.

a. The scope of work (Appendix A, Volume II of the report) states that the Architect-Engineer (A-E) shall perform field investigations of the high temperature water (HTW) distribution systems and the chilled water (CHW) distribution systems and identify and document projects. One particular alternative project is the complete replacement of the existing distribution lines with a shallow trench distribution system.

b. For the Fort Stewart HTW field investigation, the A-E is to identify the location of energy leaks, describe and estimate the cost of the Energy Conservation Opportunities (ECOs) to close these leaks, and to perform a Life Cycle Cost Analysis (LCCA) to see if these ECOs qualify for funding under either the Federal Energy Management Program (FEMP) or the Energy Conservation Investment Program (ECIP). For the Hunter Army Airfield (HAAF) field investigation, the A-E shall gather data on the Central Energy Plant (CEP) and the pinwheel barracks energy plant and interview the personnel involved with the plants. The A-E will recommend on this investigation whether or not further study of the HAAF HTW distribution systems should be programmed for the future.

c. For both the Fort Stewart CHW and the HAAF CHW, the A-E shall gather data on the Central Energy Plant (CEP) and the pinwheel barracks energy plant and interview the personnel involved with the plants. The A-E will recommend on this investigation whether or not further study of the Fort Stewart and HAAF CHW distribution systems should be programmed for the future.

d. At the interim submittal review stage, Fort Stewart and Forces Command (FORSCOM) personnel are to give guidance to the A-E on how best to package the ECO's for funding purposes.

INTERIM

NO ACTION REQUIRED.

4. FACILITY DESCRIPTION:

a. Fort Stewart has a central energy plant (CEP) and satellite energy plant (SEP). The CEP has three natural gas/fuel oil-fired package boilers and one stoker-fired wood boiler and these boilers produce high pressure steam. The CEP uses the steam in three cascade heaters to produce high temperature hot water and to feed by underground steam line the two cascade heaters in the SEP about one mile away. The SEP has no boilers.

b. The CEP HTW distribution system has about seven miles of underground lines and serves about 130 buildings. The SEP serves five buildings with about one mile of underground distribution lines.

c. A large amount of wood is burned in the CEP. As a result, the energy costs are very low. Wood contributes about 86 percent of the yearly energy consumed.

5. Make-up water use was an important parameter in the estimation of the leak losses. Since a HTW is a closed system, the water loss from leaks would be the make-up water minus blowdown and sootblowing uses. The A-E analyzed three years of data and used the last year (1995) as the base to determine the leaks found during the surveys.

6. The A-E came up with 12 ECOs to analyze for project cost; savings-to-investment ratio (SIR); simple payback; utility energy savings for electricity and heating fuels; quantity of water savings; and dollar savings for energy, water, and operations and maintenance. The ECOs are:

Number 1: Replacement of the existing HTW distribution lines with a new shallow trench distribution system.

Number 2: Reduce blowdown of the cascade heaters and the wood-fired boiler.

Number 3: Reduce soot blowing, install an exit gas temperature indicator on the wood-fired boiler.

Number 4: Repair HTW and steam leaks in the CEP and SEP.

Number 5: Repair HTW leaks in the mechanical equipment rooms.

Number 6: Repair building side DHW and HVAC hot water leaks.

Number 7: Repair HTW leaks in valve pits, drain pits and valve boxes.

Number 8: Repair underground HTW distribution system leaks.

Number 9: Reduce or eliminate HTW discharge during SEP start-up.
- Option A. Improve start-up procedure for the SEP.
- Option B. Install a new condensate/HTW return pump in the SEP.

Number 10: Use an alternative heating method to reduce SEP operating cost.
- Option A. Distribute HTW from the CEP to the SEP instead of steam.
- Option B. Shut down the SEP and use individual oil-fired boilers in the buildings served by the SEP

Number 11: Purchase leak locator equipment or contract leak locator service when a major HTW leak occurs.

Number 12: Reduce boiler and HTW system operating pressure.
- Option A. Operate at 100 psig.
- Option B. Operate at 60 psig
- Option C. Operate at 30 psig
- Option D. Operate at 15 psig.

INTERIM

7. RESULTS:

The following are CECPW's comments about the various ECOs:

a. Number 1: Replacement of the existing HTW distribution lines with a new shallow trench distribution system. The replacement of the existing distribution system with a new shallow trench system is not economical (the simple payback is nearly 100 years). This would be expected since the current system is in relatively good shape. However, if the existing buried distribution system deteriorates to the point that the entire distribution system has to be replaced, the shallow trench system would probably be the system to use.

CONCUR. WILL RECOMMEND EVALUATION OF ABOVE GROUND SYSTEM WHEN EXISTING PIPING IS NEAR THE END OF ITS USEFUL LIFE

1. When designing the distribution system, the preference is for aboveground piping, followed by shallow concrete trench, and finally direct buried systems. The US Army Corps of Engineers has developed a new (October 1994) policy for heat distribution systems (HDS). This policy was developed because of many reports of poor performance of existing steam and high temperature hot water distribution systems. This policy is for Army heat distribution systems with a carrier pipe temperature 95 degrees C and above (See Policy below).

2. The Site Classifications are A, B, C, and D. These classifications are based on underground water conditions. Class A sites have severe underground water conditions. Any piping placed underground in Class A site will have water over the top of the piping. Site B has bad underground water conditions; Class C moderate and Class D mild.

3. Technical Manual TM 5-810-17, HEATING AND COOLING DISTRIBUTION SYSTEMS, May 1994, provides criteria and guidance for the design and construction of heating and cooling distribution systems. This manual says that in most circumstances, experience has shown that aboveground systems are the most life cycle cost effective. Experience has also shown that the M & R costs of shallow concrete trench systems are lower than for direct buried systems, and they must be included in the life cycle cost analysis.

b. Number 7: Repair HTW leaks in valve pits, drain pits and valve boxes. This is a very important repair because if the pit or manhole fills with water large energy losses can result. During the survey, several pits had water up to the piping. There is a draft USACERL Technical Report on "BOILING MANHOLE HEAT LOSS CALCULATIONS" prepared by Charles Marsh and Terrill Laughton. The overall objective of this project is to develop a set of correlations that can be used in the field to estimate the heat loss from a boiling manhole for an entire year. The heat loss estimation is then used to assess the economic impact on the operations cost of the heat distribution system. Four variables are needed to calculate the heat loss of a boiling manhole: the steam pressure, average steam velocity, the total length, and the average diameter of the steam piping in the manhole. The calculated energy loss in a flooded manhole with 19 feet of piping with an average diameter of 6.5 inches for a high pressure steam distribution system is $170,000 per year at average Army energy cost rates. There are also calculations for high temperature hot water distribution systems.

CONCUR. WATER LEVEL IN PIT IS FROM GROUND WATER LEAKING IN AND SUMP PUMPS THAT DO NOT WORK. PROBLEM IS ADDRESSED IN THE O&M RECOMMENDATION

c. Number 8: Repair underground HTW distribution system leaks. This is not covered in the interim report. A survey of selected sections of the distribution was scheduled for February 1996. A print out and explanation of Renewables and Energy Efficiency Planning (REEP) is attached. One of ECOs is Underground Heat Distribution Systems Repairs and is rated about the fourth or fifth best savings-to-investment ratio. Page 448 of the CERL report shows how the costs were calculated for underground heat distribution system leak repairs.

CONCUR. ECO-8 ANALYSIS PROVIDED AT REVIEW MEETING AND WILL BE INCLUDED IN PREFINAL RPT.

INTERIM

8. In summary, it is a good report. I agree with the methodology. The assumptions seem reasonable. Much of what I wrote above is for added information and shows some of the work that is going on at CERL. CECPW-EM point of contact is Dennis Vevang; COM (703) 806-6071; DSN 656-6071; FAX -5220; INTERNET dennis.i.vevang@cpw01.usace.army.mil.

NO ACTION REQUIRED.

Encl.

Dennis Vevang
Mechanical Engineer

CF: Commander, US Army Corps of Engineers
Savannah District, ATTN: Mr. Rob Callahan
100 West Oglethorpe Avenue,
P.O. Box 889
Savannah, Georgia 31402-0889

## Response to Review Comments

**RS&H**
Reynolds, Smith and Hills, Inc.
*Architectural, Engineering, Planning and Environmental Services*

**Date:** May 28, 1996

**Reviewer:** Dennis Vevang, CECPW-EM
Construction Engineering Research Laboratories

**Response by:** William T. Todd, PE

**Subject:** Interim Submittal
Limited Energy Study, HTW Distribution System, Fort Stewart
DACA01-94-D-0038, RSH #694-1331-002

| Number | Dwg/Pg/Par. | Response | Review Action Comments |
|---|---|---|---|
| 1 - 6 | N. A. | N. A. | No action required. |
| 7.a. | Section 4.4 ECO-1 | Concur | Will add text to ECO-1 recommendations that states an above ground piping system should be evaluated when the existing system is near the end of its useful life. |
| 7.b. | Section 4.4 ECO-7 | Concur | No action required. Water found in the valve pits was primarily due to ground water leaking around the conduits and inoperable sump pumps. Water in the valve pits was usually not in contact with the HTW piping. The sump pump problem is addressed in the O&M Recommendations, Section 5.2. |
| 7.c. | Section 4.4 ECO-8 | Concur | No action required. A copy of the ECO-8 evaluation and recommendations was provided at the review meeting and will be included in the Pre-final Submittal. |
| 8 | N. A. | N. A. | No action required. |

CC: C. Warren
File

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SENT BY: 4-16-96 ;10:27AM ; FORSCOM ENGINEERS→ 9791265525442;# 1/ 1

4/16/96

FAX FOR
Rob Callahan
FAX 912 - 652 - 5442
TEL - 5246

INTERIM

NARESH KAPUR, PE
404-669-5327

**FORSCOM REVIEW COMMENTS ON INTERIM EEAP SUBMITTAL."LTD ENERGY STUDY HIGH TEMP AND CHILLED WATER DISTRIBUTION SYSTEMS, FT STEWART/HAAF,GA"**

**A VOLUME I**

1. General. This submittal is well organized. Please refer to Aug 28 submittal of RECORDS ANALYSIS AND SITE SURVEY PLAN. The important observation data and recommendations should be incorporatd in this submittal. An addendum is ok. If any aspect of the study is to be discontinued, it should be documented and agreed to by all interested parties.

CONCUR. WILL BE INCLUDED IN PREFINAL REPORT AS APPENDIX A.1C

2. General. In sec 5, for tables 5.1-2, 5.1-4 and 5.1-5, add a column for total cost saving. Also correct total of all projects cost column in table 5.1-5.

CONCUR. WILL CORRECT AND CHANGE TABLE

3. General. pl discuss PROS and CONs of recommendation for reducing the operating pressure to 60, 30, or 15 psig.

CONCUR. WILL ADD TO ECO-12 RECOMMENDATION

4. Vol I, pg 5-4. Elaborate 3,4,&5. For 7&8, have these been done? These are O&M items.

CONCUR. WILL ELABORATE. ALL ARE O&M ITEMS.

**B. VOLUME II**

5. ECO #1. Consider adding ECO description up front. This can be be done by repeating the descriptions from vol I. This will make the report more user friendly. Make special effort to look for non-energy savings and non recurring savings. This comment may be applicable to other ECOs also.

CONCUR. WILL ADD DESCRIPTIO[N] AND COMMENT ON AGE OF T[HE] SYSTEM.

6. ECO # 2. Add a brief discussion on boiler water quality issue.

CONCUR. TEXT ADDED TO ECO-2 AND SECTION 4.3

7. ECO #8. This ECO is very important. Need to describe it in detail. What approach is being taken to come up with Life Cycle coct Analysis (LCCA).

CONCUR. ECO-8 INCLUDED IN PREFINAL RPT.

8. Some appendices are missing. Are these ready now?

CONCUR. ALL APPENDICES WI[LL] BE INCLUDED [IN] PREFINAL RPT.

**C. VOLUME III**

9. Appendix B. Consider summerizing the pit valves and fittings survey form data on a spreadsheet. add an extra row for remarks as needed. 90 plus pages can be substituted by 3-4 pages of spreadsheet. Consider the same for appendix B2.

CONCUR. SUMMAR[Y] OF VALVE PITS A[ND] MECH. ROOMS WILL BE IN PREFINAL RPT

10. Appendix B4. Status?

CONCUR. WILL BE INCLUDED IN PREFINAL REPORT.

**RS&H**
Reynolds, Smith and Hills, Inc.
*Architectural, Engineering, Planning and Environmental Services*

# Response to Review Comments

**Date:** May 29, 1996

**Reviewer:** Naresh Kapur, AFPI-ENO
U. S. Army Forces Command

**Response by:** William T. Todd, PE

**Subject:** Interim Submittal
Limited Energy Study, HTW Distribution System, Fort Stewart
DACA01-94-D-0038, RSH #694-1331-002

| Number | Dwg/Pg/Par. | Response | Review Action Comments |
|---|---|---|---|
| 1 | Vol. I, General | Concur | The 8/28/95 submittal will be included in the Pre-final Submittal as Appendix A.10. |
| 2 | Vol. I, Section 5.1 | Concur | All tables will be corrected and modified for the Pre-final Submittal. |
| 3 | Vol. I, General | Concur | A discussion about operating at reduced pressures will be added to the ECO-12 recommendations in Section 4.4. |
| 4 | Vol. I, Pg 5-4 | Concur | Will elaborate on items 3, 4, and 5. All of these are O&M recommendations. |
| 5 | Vol. II, ECO-1 | Concur | A description of ECO-1 and a comment on the age and condition of the existing piping system will be added. |
| 6 | Vol. II, ECO-2 | Concur | A discussion on boiler water quality and treatment will be added as Section 4.3 and included in Section 4.4, ECO-2. |
| 7 | Vol. II, ECO-8 | Concur | Calculations, analysis and recommendations for ECO-8 will be included in the Pre-final Submittal. |
| 8 | Vol. II, General | Concur | All appendices will be included in the Pre-final Submittal. |
| 9 | Vol. III App. B.1 & B.2 | Concur | A summary list of findings for valve pits and mechanical rooms will be added for Sections B.1 and B.2, respectively. |
| 10 | Vol. III App. B.4 | Concur | The forms for Section B.4 will be included in the Pre-final Submittal. |

CC: C. Warren
File

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| MOBILE DISTRICT PROJECT REVIEW COMMENTS: | DATE: 18 July 1996 | Page 1 of 1 |
|---|---|---|
| TO: Rob Callahan, CESAS-PM-MP<br>USAED, Savannah | FROM: Anthony W. Battaglia, CESAM-EN-DM<br>Phone: (334) 690-2618 FAX: (334) 690-2424 | |

PROJECT/FY: FY95 EEAP Limited Energy Study, HTW Distribution

LOCATION: Fort Stewart, GA

TYPE REVIEW: Pre-final Submittal

| NO. | Page/Par | COMMENT | Response to Comment |
|---|---|---|---|
| 1. | General | The statistical analysis of the makeup water data was a very good approach; it allowed some sense to made of what could have been very confusing. | CONCUR |
| 2. | Pg 2-2 | Figure 2.2-1: On page 3-3 and on page 4-1, there are references to condensate and HTW return lines from the SEP to the CEP. Please include these lines in Fig 2.2-1. | CONCUR |
| 3. | Pg 3-1 | Par 3.2: Some additional losses that could be included are the deaerator vent and any steam traps that dischrge to the atmosphere or to a floor drain. | CONCUR |
| 4. | Pg 3-4 | On the first line, it appears that the phrase, "subtracted from" should be changed to "added to". | CONCUR |
| 5. | Pg 4-42 | Analysis - Option B: Change "50 psig" to "35 psig". | CONCUR |
| 6. | Pg 4-42 | Analysis - Option C: Are the boilers at the hospital currently being operated, or are they sitting idle? | CONCUR |
| 7. | Pg 4-43 | Analysis - Option D: The discussion of the HTW-to-Steam generators should be clarified. The temperature of the HTW must be higher than the saturation temperature corresponding to the desired steam pressure, otherwise there will be no heat transfer. | CONCUR |
| 8. | Pg 4-43 | Results and Recommendations: Options C & D should include an operation and maintenance cost for the operation of the hospital boilers. | CONCUR |

**RS&H**

# Response to Review Comments

Reynolds, Smith and Hills, Inc.
*Architectural, Engineering, Planning and Environmental Services*

**Date:** August 20, 1996

**Reviewer:** Anthony W. Battaglia, CESAM-EN-DM
U. S. Army Engineer District, Mobile

**Response by:** William T. Todd, PE

**Subject:** Pre-final Submittal
Limited Energy Study, HTW Distribution System, Fort Stewart
DACA01-94-D-0038, RSH #694-1331-002

| Number | Dwg/Pg/Par. | Response | Review Action Comments |
|---|---|---|---|
| 2 | Volume I<br>Pg 2-2 | Concur | The terms "HTW return" and "condensate return" are used interchangeably in the text. To avoid confusion "condensate return" will be changed to "HTW return" on page 3-3. Figure 2.2-1 will be revised to show the HTW return pipe. |
| 3 | Volume I<br>Pg 3-1 | Concur | This sentence will be modified to: "The known system losses include soot blowing, boiler blowdown, cascade heater blowdown, the deaerator vent and other miscellaneous leaks within the CEP." |
| 4 | Volume I<br>Pg 3-4 | Concur | The SEP tests quantified the leak rate from the SEP without blowdown so the blowdown should not be subtracted from the results. This sentence will be changed to: "The amount of water used for blowdown and other miscellaneous leaks must be added to the estimated loss rate from the above procedure to determine the total HTW losses from the SEP." |
| 5 | Volume I<br>Pg 4-42 | Concur | Will change "50 psig" to "35 psig" in the second sentence of Analysis - Option B. |

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| | | | |
|---|---|---|---|
| 6 | Volume I<br>Pg 4-42 | Concur | To clarify this point the text will be modified to: "The existing heating and cooling plant at the hospital is only utilized when the CEP is not operational." |
| 7 | Volume I<br>Pg 4-43 | Concur | In order provide a sufficient temperature difference to produce steam at 15 psig, the steam generators require a minimum HTW system pressure of 25 to 30 psig. Therefore, Option D will be removed from this ECO. |
| 8 | Volume I<br>Pg 4-43 | Concur | Will add operation and maintenance costs for Option C. |

CC: C. Warren
File

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# A.8 LIST OF ABBREVIATIONS AND ACRONYMS

# ABBREVIATIONS

| | |
|---|---|
| ABMA | American Boiler Manufacturer's Association |
| ABS | Absorption |
| Btu | British thermal units |
| BFP | Boiler Feed Pump |
| BFW | Boiler Feed Water |
| C-1 | Cascade Heater No. 1 |
| CEP | Central Energy Plant |
| CHW | Chilled Water |
| DA | Deaerator |
| DHW | Domestic Hot Water |
| DPW | Directorate of Public Works |
| ECO | Energy Conservation Opportunities |
| EEAP | Energy Engineering Analysis Program |
| FEMP | Federal Energy Management Program |
| FSEO | Fort Stewart Energy Officer |
| GPD | Gallons per Day |
| GPM | Gallons per Minute |
| HHW | Heating Hot Water |
| HPS | High Pressure Steam |
| HTW | High Temperature Water |
| HTWR | High Temperature Water Return |
| HTWS | High Temperature Water Supply |
| kGal | 1,000 Gallons |
| LF | Linear Feet |
| LPS | Low Pressure Steam |
| MBtu | Million British thermal units |
| MPS | Medium Pressure Steam |
| MUW | Make-up Water |
| O&M | Operation and Maintenance |
| OMA | Operation and Maintenance, Army |
| P&A | Puckorius & Associates |
| PPM | Parts per million |
| PRS | Pressure Reducing Station |
| psig | pound per square inch |
| RS&H | Reynolds, Smith and Hills, Inc. |

| | |
|---|---|
| SEP | Satellite Energy Plant |
| SIR | Savings to Investment Ratio |
| TDS | Total Dissolved Solids |
| WM | Water Meter |
| WS | Water Softener |

# A.9 CORRESPONDENCE AND MEETING NOTES

CSW

**DEPARTMENT OF THE ARMY**
SAVANNAH DISTRICT, CORPS OF ENGINEERS
P.O. BOX 889
SAVANNAH, GEORGIA 31402-0889

REPLY TO
ATTENTION OF:

Military Branch

SUBJECT: Request for Proposal for Delivery Order No. 2 Under Contract No. DACA01-94-D-0038, Indefinite Delivery Contract for Architect-Engineer Services for the Army Energy Engineering Analysis Program (EEAP) for the Southeast Region, Including Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Puerto Rico, and South Carolina

Reynolds, Smith and Hills, Incorporated
Attention: Mr. Carlos Warren
4651 Salisbury Road
Jacksonville, Florida 32256

Gentlemen:

I refer to the conversation of February 17, 1995, between Mr. Carlos Warren of your firm and Mr. Rob Callahan of the Savannah District regarding the incorporation of work into your referenced contract. The work is described in the attached Appendix A for Delivery Order Number 2.

There will be a prenegotiation conference in building number T-1139 at Fort Stewart on February 28, 1995, beginning at 9:00 am. Your firm should be appropriately represented at the meeting and be prepared to ask any questions you need to clarify the Appendix A for this project.

Please furnish your fee proposal in detail by separate item of work as outlined on the attached "Suggested Format for Architect-Engineer Fee Proposal" to the attention of the Architect-Engineer Contract Section (CESAS-EN-EA) by March 8, 1995. The estimate shall include all project costs.

You are to mark the envelope containing your fee proposal in the lower left corner "Architect-Engineer Fee Proposal". After receipt of your fee proposal, you will be contacted by an approved District negotiator for the purpose of establishing a date for fee negotiations.

You are not to proceed with this work until the negotiations are concluded and the notice to proceed is issued. You are cautioned that your participation in the prenegotiation conference and the preparation of your fee proposal are entirely at your own risk. Further, in the event of unsatisfactory fee negotiations, the Government can assume no obligation for payment

of any expense incurred by your firm in the preparation of your fee. The award of delivery orders is subject to the approval of the Contracting Officer.

If you have any questions concerning this additional work, please contact the Project Manager, Mr. Rob Callahan, of the Reimbursable Management Team, at telephone number (912) 652-5426.

Sincerely,

Warren T. Clarke

Warren T. Clarke
Authorized Representative of the
Contracting Officer

Attachment

Copies Furnished (wo/enclosures):

Commander, 24th Infantry Division and Fort Stewart, Attention: AFZP-DEV (Mr. Randy Jones), Fort Stewart, Georgia 31314
Commander, U.S. Army Forces Command, Attention: AFPI-ENO (Mr. Naresh Kapur), Fort McPherson, Georgia 30330

2/27/95

Fort Stewart Survey

A. Pre-Survey

(1) Obtain set of distribution system maps from Ft S. GIS Operator / Systems Analysis Branch

(2) Obtain copy of any previous studies

(3) Copy of work orders and/or service orders past 12 months from Resources Mgt Div / FE Division

(4) Interview personnel (?) Include HAAF

(5) Review make-up water logs

B. Develop Plan

C. Field Survey

(1) Develop data forms

(2) Appoint field survey manager

2/28/95

Pre-Negotiate

(1) 14,000 gal/day HTW make-up

(2) HAAF study option.

(3) Randy wants system evaluation. (distribution only)

CESAS-PM-MR-2 28 Feb 95

MEMORANDUM FOR RECORD

SUBJECT: Prenegotiation Conference for Delivery Order No. 2 under Contract No. DACA01-94-D-0038, Indefinite Delivery Contract for Architect-Engineer Services for the Army Energy Engineering Analysis Program (EEAP) for the Southeast Region including Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Puerto Rico, and South Carolina

1. The undersigned called the subject meeting to order on 28 February 1995 at 0900 in the Fort Stewart DPW conference room. I stated the purpose of the meeting and circulated the sign-in sheet. Project team members in attendance are shown at encl 1.

2. Everyone had already introduced themselves, so we proceeded on into our review of the draft Appendix A, or Scope of Work, for the project. We immediately got sidetracked into discussing additions to the Scope. We bounced ideas around, performed a map review, and then broke for lunch. Following lunch, we reconvened the meeting in the Central Energy Plant (CEP) manager's office. When we finished there, we did a short field investigation of some exposed distribution system piping and a few valve pits and placed a telephone call to the Repair Branch supervisor, Gene Smith, to solicit his thoughts on where water leaks exist. We discussed survey techniques that the A-E would use for the project. We decided if the A-E had to remove any pipe insulation in order to attach flow meters that Doug would initiate a DPW work request to have it repaired so that the A-E's field crew would be relieved of this responsibility.

3. The conclusion of the team from the day's work was that I would redraft the Appendix A to incorporate more work and that the work needed to proceed in a different sequence from that which I had described in the draft Scope.

4. The final revised version of the project Appendix A is attached at encl 2. It incorporates all the changes needed to bring the Scope into line with the customer's desires.

5. The order in which the A-E will perform the work now will be:

a. Perform the review of records on the Fort Stewart (FS) chilled water system (CHW).

b. Perform the review of records on the Hunter Army Airfield (HAAF) high temperature water systems (HTW) and CHW systems for both the CEP and the pinwheel barracks energy plant.

c. Submit recommendations, with back-up justification, on the FS CHW distribution system and the HAAF HTW/CHW systems along with the plan for the field investigation. The field investigation plan will address both the FS HTW and CHW system surveys, if the A-E's recommendation is to perform the detailed field study of the FS CHW

system.

d. Perform the field investigations.
e. Submit the interim report.
f. Submit the pre-final report.
g. Submit the final report.

6. Doug, Carlos, and I signed our Partnering Agreement (encl 3). I adjourned the meeting at about 1400.

Robert A. Callahan

Robert A. Callahan
Project Manager

# CONFERENCE PARTICIPANTS

| | |
|---|---|
| Project High Temp & Chilled Water Distribution System Study | Date: 28 Feb 95 |
| Base: Ft. Stewart | Time: 0900 |
| Fiscial Year 1995 | Local: |
| Line Item | Type: Pre-negotiation |

| Name | Position | Organization | Office Sym. | Telephone |
|---|---|---|---|---|
| 1. Rob Callahan | Project Manager | Corps of Engineers Savannah District | CESAS-PM-MR | (912) 652-5246 DSN: 971-6330, ext. 524 |
| 2. RANDY JONES | ENERGY Coordinator | DPW Energy | AFZP-DEV | ~~912 654-~~ 912 767-7925 |
| 3. D.H. SWANSON | ENERGY ENG | DPW ENERGY | AFZP-DEV | 352-5535 912-767-8880 |
| 4. W.T. Todd | Engineer | RS & H | — | 904-279-2281 |
| 5. Carlos Warren | Proj Mgr. | RS & H | | 904-279-2275 |
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DEPARTMENT OF THE ARMY
SAVANNAH DISTRICT, CORPS OF ENGINEERS
P.O. BOX 889
SAVANNAH, GEORGIA 31402-0889

REPLY TO
ATTENTION OF:

CESAS-PM-MP-2 8 Mar 95

MEMORANDUM FOR

Commander, 24th Infantry Division & Ft. Stewart, ATTN: AFZP-DEV (Mr. Swanson), Ft. Stewart, GA 31314
Commander, U.S. Army Forces Command, ATTN: AFPI-ENO (Mr. Kapur), Ft. McPherson, GA 30330
Commander, U.S. Army Engineer Division, South Atlantic, ATTN: CESAD-EN-TE (Mr. Baggette), 77 Forsythe Street, SW, Atlanta, GA 30335-6801
Commander, U.S. Army Engineer District, Mobile, ATTN: CESAM-EN-DM (Mr. Battaglia), P.O. Box 2288, Mobile, AL 36628-0001

SUBJECT: Delivery Order No. 2 Under Contract No. DACA-01-D-0038, Indefinite Delivery Contract for Architect-Engineer Services for the Army Energy Engineering Analysis Program (EEAP) for the Southeast Region Including Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Puerto Rico, and South Carolina

I am enclosing the minutes of the Prenegotiation Conference for the subject project held at Fort Stewart on 28 Feb 95. Please advise the Project Manager, Rob Callahan, of any additions, deletions, or corrections to these minutes.

FOR THE COMMANDER:

Encl

Warren T. Clarke

WARREN T. CLARKE, R.A.
Acting Chief, Military Programs and
Project Management Branch

CF:
Reynolds, Smith and Hills, Inc., ATTN: Mr. Carlos Warren, 4651 Salisbury Road, Jacksonville, FL 32256

# CONFERENCE PARTICIPANTS

| | | | |
|---|---|---|---|
| Project HHW & CHW Dist. Study | | Date: | 1/28/95 |
| Base: | | Time: | 1330 |
| Fiscial Year | | Local: | Ft Stewart GA |
| Line Item | | Type: | |

| Name | Position | Organization | Office Sym. | Telephone |
|---|---|---|---|---|
| 1. Rob Callahan | Project Manager | Corps of Engineers Savannah District | CESAS-PM-MR | Com (912)652-5246 DSN 971-6330, ext. 524 |
| 2. Naresh Kapur | Mech Engr | HQ. FORSCOM DCSPIM-Engr | AFPI-ENO | Com 404-669-5327 FAX 7751 |
| 3. Roger Green | DPW Repairs | | | 767-2138 |
| 4. Doug Swanson | DPW-Energy | DPW-ENRD | AFZP-DEV | 352-5535 |
| 5. Bill Todd | Mech. Eng. | RS&H | Jax | 904-279-2281 |
| 6. Carlos Warren | Proj. Mgr | RS&H | Jax | 904-279-2275 |
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(1)

# MEETING NOTES

6/28/95

- $10.82 /ton for wood chips

- Chilled water pipe is asbestos with asbestos insulation and asbestos pipe jacket.

- 600 Block 1st } not as many leaks even though
  700 Block 2nd } these are the oldest systems.
  800 Block

- Records review
  - HTW at Ft Stewart
  - CHW at " "
  - HTW at Hunter
  - CHW at "

- Chris Harley in charge of Boiler Plant

- Doug S. is place to start for information.

- Meter at valve pits and test potable water for sulfite or other boiler feed water chemical.

* Check on type of insulation on High Temp. Pipes

- Worst problem is 4500 block - the newest system
  - This loop is shut down during the summer water sits in the pipe all summer

A.9-9

wtt
2

6/28/95

- ~~EEAP~~ EAP Study for capacity of system and load of buildings on the system

- Cost Est.
ECO Analysis
Form 1391 later?

- Rob's schedule is about 52 weeks.

- Coordinate F. Survey w/ boiler plant operation.

- Have Doug write a memo giving us access to the base to perform the survey

CHW - 120 psi for Zone 1 & 2
80 psi for Zone 3 which is the longest run

- Zone 1: 700 & 800 Block - must keep pressure up for these areas
- Zone 2 bldg 440 - not cooled properly unless pressure is high

**RS&H**
*Architectural, Engineering, Planning and Environmental Services*

**Reynolds, Smith and Hills, Inc.**
4651 Salisbury Road
Jacksonville, Florida 32256
904•296•2000
Fax 904•279•2491

FL. Cert Nos AAC001886 • EB0005620 • LCC000210

July 19, 1995

Department of the Army
Savannah District
Corps of Engineers
100 W. Oglethorpe Avenue
Savannah, GA 31402-0889

Attn: Warren T. Clarke
Contracting Officer Representative

Subject: **Contract No. DACA01-94-D-0038**
**Delivery Order Number 2**
**Limited Energy Study of High Temperature and Chilled Water Distribution Systems at Fort Stewart and Hunter Airfield, Georgia**
**AEP File No. 6941331002**

Gentlemen:

Pursuant to Paragraph 5.1, Appendix A of the referenced Delivery Order, the following individuals are designated:

| | |
|---|---|
| Project Manager | Carlos S. Warren, PhD, PE |
| Field Survey Manager | William T. Todd, PE |

Your concurrence is respectfully requested.

Very truly yours,

Carlos S. Warren, PhD, PE
Vice President - Energy Services

/gk
cc W. Todd
Distribution

DISTRIBUTION

Commander
24th Infantry Division and Fort Stewart
ATTN: AFZP-DEV (Mr. Doug Swanson)
Fort Stewart, GA 31314

Commander
U. S. Army Forces Command
ATTN: AFPI-ENO (Mr. Naresh Kapur)
Fort McPherson, GA 30330

Savannah District, Corps of Engineers
ATTN: CESAS-PM-MR (Mr. Rob Callahan)
100 W. Oglethorpe Avenue
P. O. Box 889
Savannah, GA 31402-0889

Mobile District, Corps of Engineers
ATTN: CESAM-EN-DM (Mr. Tony Battaglia)
P. O. Box 2288
Mobile, AL 36628-0001

*RS&H*

# MEMORANDUM

**Date:** 1 September 1995

**To:** Savannah District, Corps of Engineers
ATTN: CESAS-PM-MR (Mr. Rob Callahan)
PO Box 889
Savannah, GA 31402-0889

**From:** Carlos S. Warren, PhD, PE
Project Manager

**Subject:** Monthly Progress Report
Limited Energy Study, Hunter Army Airfield and Ft. Stewart
HTW and CHW Distribution Systems
Contract No. DACA01-94-D-0038/0002

---

The following progress was made on the subject contract during the month of August 1995:

1. Site visit was accomplished by the Project Manager (PM) and the Site Survey Manger (SSM) 02 - 04 August. The purpose of the site visit was to gather sufficient data and records to recommend whether or not to conduct detailed surveys and analyses of the HAAF CHW and heating distribution lines and the Ft. Stewart CHW distribution lines.

2. Additional data and drawings were also obtained on the Ft. Stewart HTW distribution system.

3. The scheduled report "Records Analysis and Site Survey Plan" was distributed on 28 August 1995.

Work planned for September 1995:

1. Begin activities to prepare for the initial site survey scheduled to begin 23 October 1995. Equipment and necessary subcontractors will be committed. If judged worthwhile, the site survey may be started ahead of schedule.

cc: Doug Swanson

**RS&H®**

**Telephone Call Confirmation**

Project Number 694-1331-002

Local ____ L.D. ____ Placed ____ Rec'd ____ Date 9-6-95

Conversed with Rob Callahan Of COE - Savannah District

Regarding Fort Stewart HTW Distribution Study

---

They have just hired a new energy coordinator at Fort Stewart. His name is Tim Harper and he will be replacing Doug Swanson as our point of contact for this project. His office is in the FE Division and his temporary phone number is 912-767-2446. I told Rob I would call Tim this week to get acquainted. They would also like a week or two advance notice prior to each site visit. Rob has reviewed the survey plan and is very pleased/impressed with it.

There is a design and construction contractor that would like to "look over our shoulder" during the site survey. I said that would be ok as long as they did not slow us down.

---

Distribution: C. Warren

β1

**RS&H**®

September 15, 1995

To: Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

From: William T. Todd, PE
Field Survey Manager

Subject: **Weekly Field Survey Progress Report**
**Limited Energy Study**
**Hunter Army Airfield and Ft. Stewart**
**HTW and CHW Distribution Systems**
**Contract No. DACA01-94-D-0038/0002**

---

The following progress was made on the subject contract during the week ending 15 September 1995:

1. Site visit was accomplished b the Field Survey Manager on 13 September. The purpose of the site visit was to:

   A. Locate HTW system make up water, chemical feed and blow down pipes to be metered and determine if pipe insulation removal is required. The make up water pipe was located and flow estimates for the two chemical feed systems and 12 blow down systems were obtained from conversations with the plant operations staff. Some pipe insulation will have to be removed if the metering effort is required. The CEP operations staff will be notified after a decision has been made.

   B. Obtain copies of recent HTW and potable water sample analysis reports. Copies of analysis reports for boiler water, cascade heater water (HTW), make up water, condensate, and cooling tower make up water (potable water) were obtained from the CEP records.

2. Pump and pump motor nameplate data was taken for the three HTW system zones served by the CEP. This effort was originally scheduled for the October field survey, however, time permitted it during this visit. We can now go ahead and pursue the pump curves from the manufacturer.

Additional field survey work planned for September 1995:

1. No additional field survey work is planned until the initial site survey which is scheduled to begin 23 October 1995. If judged worthwhile, the initial site survey may be started ahead of schedule. We will notify the FESO and Savannah District accordingly.

/gk
cc Tim Harper

# Transmittal Letter

**RS&H**
Architecture, Engineering and Planning

**To:** Mr. Robert Meston
Utility Services Assoc. Inc.
10013 Martin Luther King Jr. Way, S.
Seattle, WA 98178

**Date:** 9/20/95

**Project:** Fort Stewart
HTW and CHW Distribution

**Project No:** 694-1331-002

We Transmit:
( X) herewith
( ) under separate cover

For Your:
( ) approval
(X ) review & comment
(X ) use

The Following:

| Copies | Date | Description |
|---|---|---|
| 1 | --- | Piping System Information |
| 1 | --- | HTW Distribution System Map |

Remarks: Please prepare a quote for USA to provide leak detection and locating services based on the attached information.

Copies To: C. Warren

Reynolds, Smith and Hills, Inc.
4651 Salisbury Road
Jacksonville, Florida 32256
904•296•2000 Fax 904•279•2491

FL. Cert. Nos. AAC001886 • EB0005620 • LCC000210

By: William T. Todd
William T. Todd, PE

**RS&H**

***MEMORANDUM - VIA FAX*** ***Architectural, Engineering, Planning and Environmental Services***

**Date:** 9-27-95

**To:** Mr. Tim Harper
**From:** William T. Todd
**Project:** Fort Stewart HTW Leak Study
**A/E No.:** 694-1331-002
**Subject:** Building Hot Water Generator Survey

---

This memo is to provide written conformation of our telephone conversation regarding the building hot water generator survey planned for next week. As we discussed, our team will be at Fort Stewart for three to five days beginning Monday morning (10-2-95). We will be taking water samples from buildings that utilize the HTW system to produce domestic hot water.

Also, as per our conversation, please have a letter of authorization prepared that will allow us access to the buildings. The survey team will consist of the following people:

William T. Todd, Field Survey Manager
Paul F. Hutchins
George W. Fallon

Please call me if you have any questions. I look forward to meeting you next week.

---

Copies To: Mr. R. Callahan (Via Fax)
C. Warren

# FORT STEWART, ENRD, ENVIRONMENTAL BRANCH

Date: 28 SEPT 95
Number of Pages (inc. cover sheet): 2

| To: Bill Todd | From: Tim Harper |
| --- | --- |
| Phone: | Phone: 912-767-4903 |
| Fax: | |
| CC: | Fax: |

Remarks: ☐ Urgent ☐ For your review ☐ Reply ASAP ☐ Please comment

Bill,

I believe this will be sufficient! Let me know if you need anything else. Look forward to meeting w/ you next week.

Tim Harper

AFZP-DEF (420-10a) 28 Sep 95

MEMORANDUM FOR RECORD

SUBJECT: Water samples for Fort Stewart HTW Leak Study

1. The week beginning 2 Oct 95, RS&H will be at Fort Stewart taking hot water samples. The following individuals will need to enter buildings that utilize the HTW system: William T. Todd (Field Survey Manager), Paul F. Hutchins, and George W. Fallon.

2. POC is Tim Harper, extension 4903.

Timothy D. Harper

TIMOTHY D. HARPER
Energy Engineer, FE Division

RS&H®

October 6, 1995

To: Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

From: William T. Todd, PE wtt
Field Survey Manager

Subject: **Weekly Field Survey Progress Report**
**Limited Energy Study**
**Ft. Stewart HTW Distribution System**
**Contract No. DACA01-94-D-0038/0002**

---

The following progress was made on the subject contract during the week ending 6 October 1995:

1. Site survey was performed by Paul Hutchins, George Fallon and the Field Survey Manager from 2 - 4 October, 1995. The following items were accomplished during the site visit:

   A. The HTW distribution system leaks were determined by turning off all blow down and soot blowers in the CEP for 8 hours and measuring the makeup water required to refill the cascade heaters. This test will be performed again when the satellite energy plant is operational.

   B. Obtained HTW, domestic hot water and potable water samples for analysis. The analysis will be used to determine if the heat exchangers are leaking HTW into the domestic hot water generators in the barracks and dining facilities.

Additional field survey work planned:

1. No additional field survey work is planned until the satellite energy plant (SEP) is operational. This survey, which will include valve pits and mechanical rooms, is scheduled to begin 6 November 1995. If the SEP is not operating, the site survey may be started at a later date. We will notify the FESO and Savannah District accordingly.

/gk
cc T. Harper (FESO)
C. Warren (PM)

**RS&H**

*MEMORANDUM* *Architectural, Engineering, Planning and Environmental Services*

**To:** Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

**Date:** 26 October 1995

**From:** Carlos S. Warren, PhD, PE
Project Manager

**Project:** Limited Energy Study - Hunter Army Airfield and Ft. Stewart
HTW and CHW Distribution System
Contract No. DACA01-94-D-0038/0002
A/E No. 694-1331-002

**Subject:** Monthly Progress Report

---

The following progress was made on the subject project during the month of October 1995:

1. Site survey was accomplished the week of 2 October 1995. The purposes of the site visit were to obtain potable water samples from the buildings with HTW generators to identify possible water leaks from the heat exchanger in the generator, and to measure the makeup water required to refill the cascade heaters. A report on the survey was submitted by the Field Survey Manager to the addressee on 6 October 1995.

2. The analysis of the water samples was received on 23 October 1995. Of the 53 buildings sampled, 22 samples showed sufficient quantities of phosphates and/or sulfates (present in the HTW) to suspect leaks.

3. Observations were made of leak detection in underground water lines using ultrasonic technology. This method will be used to survey the Ft. Stewart HTW lines. The equipment and operator have been tentatively scheduled for a survey the week of 15 January 1996.

Work planned for November 1995:

1. Survey of the valve pits and mechanical rooms containing suspected HTW heat exchanger leaks will commence when the satellite energy plant is operational.

---

Copies To: Tim Harper (FESO)
W. Todd

A.9-22

**RS&H**

*Architectural, Engineering, Planning and Environmental Services*

## *MEMORANDUM - VIA FAX*

**To:** Mr. Tim Harper **Date:** 11-3-95

**From:** William T. Todd

**Project:** Fort Stewart HTW Leak Study

**A/E No.:** 694-1331-002

**Subject:** Field Survey Schedule

---

9

Our next field survey of the Fort Stewart HTW distribution system is scheduled to take place next week (11/06/95-11/10/85). One of the main objectives of this survey is to determine the total volume of HTW losses during full heating operation. However, as described in our most recent progress report, the Satellite Energy Plant (SEP) must be operational so we can quantify the leakage rate of the entire HTW distribution system during the heating season.

I called the operator of the Central Energy Plant today and he said the SEP was still not operating. He expected it would be running within the next couple of weeks. We will check on the status of the SEP each week and schedule the next field survey as soon as possible after the SEP is operational.

Please call me if you have any questions regarding the field survey schedule.

---

Copies To: Mr. R. Callahan (Via Fax)
C. Warren

AFZP-DEF (420-10a) 27 Nov 95

MEMORANDUM FOR RECORD

SUBJECT: Fort Stewart HTW Leak Study

1. The week beginning 27 Nov 95, RS&H will be at Fort Stewart taking hot water samples. The following individuals will need to enter buildings that utilize the HTW system: William T. Todd (Field Survey Manager) and George W. Fallon.

2. POC is Tim Harper, extension 4903 or 9451.

Timothy D. Harper

TIMOTHY D. HARPER
Energy Engineer, FE Division

β T

**RS&H**

*MEMORANDUM* — *Architectural, Engineering, Planning and Environmental Services*

**To:** Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

**Date:** 29 November 1995

**From:** Carlos S. Warren, PhD, PE
Project Manager

**Project:** Limited Energy Study - Hunter Army Airfield and Ft. Stewart
HTW and CHW Distribution System
Contract No. DACA01-94-D-0038/0002
A/E No. 694-1331-002

**Subject:** Monthly Progress Report

---

The following progress was made on the subject project during the month of November 1995:

1. Evaluated the test results of the domestic hot water samples and selected buildings to revisit and perform leak tests.

2. Began writing Introduction, Facility Description and Methodology sections of Interim Report.

3. Site survey was accomplished during the week of 27 November 1995. The following items were accomplished during this field investigation:

   - Measured make up water to the CEP during heating season.
   - Measured make up water to the SEP
   - Surveyed valve pits
   - Surveyed more mechanical equipment rooms
   - Measured miscellaneous leaks within the CEP and the SEP

Work planned for December 1995:

1. Analyze data collected during field investigations and calculate annual cost of HTW distribution system leaks.

2. Continue drafting Interim Report.

---

Copies To: Tim Harper (FESO)
W. Todd

# Transmittal Letter

**RS&H**
Architecture, Engineering and Planning

**To:** Commander
24th Infantry Division and Ft. Stewart
ATTN: AFZP-DPW-OB FAC DIV (Mr. Randy Parks)
Fort Stewart, Georgia 31314-5000

**Date:** 12/8/95

**Project:** Fort Stewart HTW Distribution System Study

**Project No:** 6941331002

We Transmit:
(X) herewith
( ) under separate cover

For Your:
( ) approval
( ) review & comment
(X) use

The Following:

| Copies | Date | Description |
|---|---|---|
| 1 | --- | Fuel Tank Capacity (w/o baffle) by height in inches |
| 1 | --- | Fuel tank capacity (with baffle) by height in inches |

Remarks: These are good estimates of the usable fuel tank capacities, one with and one without a baffle. If George measured the tanks correctly, these values should be accurate within 10 to 15 gallons. Please call me if you have any questions.

Copies To:

Reynolds, Smith and Hills, Inc.
4651 Salisbury Road
Jacksonville, Florida 32256
904•296•2000
Fax 904•279•2491

By: Bill Todd
William T. Todd, PE

**RS&H**
Reynolds, Smith and Hills, Inc.
*Architectural, Engineering, Planning and Environmental Services*

# Memorandum

**Date:** December 28, 1995

**To:** Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP ( Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

**From:** Carlos S. Warren, PhD, PE
Project Manager

**Subject:** Monthly Progress Report
Contract No. DACA01-94-0038/0002
Limited Energy Study - Hunter Army Airfield and Ft. Stewart HTW and CHW Distribution System

---

The following progress was made on the subject project during the month of December 1995:

1. Added water temperature data, reevaluated the test results of the domestic hot water samples and selected buildings to revisit and perform leak tests.

2. Continued working on draft of Interim Report.

3. Analyzed data collected during November field investigation. Results of the analysis include:

   - Test to measure make up water to Zones 1, 2 and 3 during heating season were inconclusive. We will retry this test during January site visit.

   - Test to measure make up water to the SEP Zone indicated this was a very tight distribution system.

   - Began calculations to quantity leaks found during survey of valve pits, mechanical equipment rooms, the CEP and the SEP.

4. Canceled ultrasonic leak detection test scheduled for January based on the low volume flow of leaks within the distribution system (less than 4 g.p.m.).

5. Investigating video thermography to locate HTW system leaks.

Monthly Progress Report
Memorandum to Callahan
28 December 1995
HAAF and Ft. Stewart HTW and CHW Distribution Systems

Work planned for January 1996:

1. A field investigation is scheduled for January 15-19. The goals are:

   - Survey remaining mechanical rooms (approximately 60) for leaks.

   - Test hot water generator/heat exchangers suspected of leaks.

   - Repeat test for make-up water to Zones 1, 2 and 3.

2. Analyze data collected during field investigations and calculate annual cost of HTW distribution system leaks.

3. Continue drafting Interim Report.

---

/gk
Copies to: T. Harper (FESO)
W. Todd

RS&H

## MEMORANDUM

February 5, 1996

**TO:** Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

**FROM:** Carlos S. Warren, PhD, P.E. - Project Manager

**SUBJECT:** Monthly Progress Report
Contract No. DACA01-94-0038/0002
Limited Energy Study - Hunter Army Airfield and Ft. Stewart HTW and CHW Distribution System

---

The following progress was made on the subject project during the month of January 1996:

1. Performed field investigation to survey about 60 mechanical equipment rooms, test hot water generators/heat exchangers for leaks and correct errors to make-up water use data.

2. Continued working on project analysis and draft of Interim Report.

3. Scheduled the ultrasonic leak detection test for February 21-23.

4. Investigated video thermography to locate HTW system leaks. Rejected this method based on high costs.

Work planned for February 1996:

1. A field investigation is scheduled for February 21-23. The goals are:

   - Survey selected sections of the underground HTW distribution piping.

   - Use ultrasonic leak detection equipment to locate leaks.

2. Complete analysis and submit Interim Report.

/kw

cc: T. Harper (FESO)
W. Todd

RS&H

# MEMORANDUM

February 5, 1996

TO: Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

FROM: William T. Todd, P.E.
Field Survey Manager

SUBJECT: **Weekly Field Survey Progress Report**
**Limited Energy Study**
**Hunter Army Airfield and Ft. Stewart**
**HTW and CHW Distribution Systems**
**Contract No. DACA01-94-D-0038/0002**

---

The following field investigation progress was made on the subject contract during the week ending 19 January 1996:

1. Site visit was accomplished on 16-18 January. The purpose of the site visit was to:

   A. Survey remaining mechanical rooms (about 60 rooms) for HTW leaks.

   B. Test hot water generators and heat exchangers suspected of leaking.

   C. Correct errors and explain extreme data from boiler logs.

Additional field survey work planned:

1. The next and final field survey work is planned for February 21-23. We will be testing the underground HTW pipes using ultrasonic leak detection equipment.

/kw

cc: Tim Harper
N. Kapur (via fax)
C. Warren

I:\todd\sav\02-05.mem

**Transmittal Letter**

**Reynolds, Smith and Hills, Inc.**
*Architectural, Engineering, Planning and Environmental Services*

| | | | |
|---|---|---|---|
| To: | Attached Distribution List | Date: | February 16, 1996 |
| Project: | Limited Energy Study<br>HTW and CHW Distribution Systems<br>Fort Stewart and Hunter AAF | Project No.: | 6941331002 |

We Transmit:

( X ) Herewith ( ) Via Fax ( ) Hand Carried
( ) Under Separate Cover Via:
( ) In Accordance with Your Request
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( X ) Review and Comment
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( ) Signature

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| As per distribution list | 2-19-96 | Vol. II Appendicies |
| As per distribution list | 2-19-96 | Vol. III Field Investigation Forms |

Remarks: Volume III is being supplied in 3-ring binders because these forms will not change. Updated covers and inserts will be sent with future submittals.

/kw
Copies To:

Reynolds, Smith and Hills, Inc.
4651 Salisbury Road
Jacksonville, Florida 32256
(904) 296-2000 Fax: (904) 279-2491

FL Cert. Nos. AAC001886•EB0005620•LCC000210

By: William T. Todd
William T. Todd, P.E.

I:todd\int.rpt

A.9-32

Limited Energy Study
HTW and CHW Distribution Systems
Fort Stewart and Hunter AAF

INTERIM REPORT

NO. COPIES

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|---|---|
| 2 | Commander<br>24th Infantry Division and Fort Stewart<br>ATTN: AFZP-DEV (Mr. Tim Harper)<br>Fort Stewart, GA 31314 |
| 1 | Commander<br>U. S. Army Forces Command<br>ATTN: AFPI-ENO (Mr. Naresh Kapur)<br>Fort McPherson, GA 30330 |
| 2 | Savannah District Corps of Engineers<br>ATTN: CESAS-PM-MR (Mr. Rob Callahan)<br>100 W. Oglethorpe Avenue<br>P. O. Box 889<br>Savannah, GA 31402-0889 |
| 1 | Mobile District, Corps of Engineers<br>ATTN: CESAM-EN-DM (Mr. Tony Battaglia)<br>P. O. Box 2288<br>Mobile, AL 36628-0001 |

**RS&H**

Reynolds, Smith and Hills, Inc.
*Architectural, Engineering, Planning and Environmental Services*

# Memorandum

**Date:** March 1, 1996

**To:** Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP ( Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

**From:** William T. Todd, PE Bill
Field Survey Manager

**Subject:** Weekly Field Survey Progress Report
Contract No. DACA01-94-0038/0002
Limited Energy Study - Hunter Army Airfield and Ft. Stewart HTW and CHW Distribution System

---

The following investigation progress was made on the subject project during the week ending 23 February 1996:

> Site visit was accomplished on February 21. The purpose of the site visit was to use ultrasonic leak detection equipment to locate leaks in selected sections of the underground HTW distribution piping. Ultrasonic leak detectors and a microprocessor - based leak correlation equipment were used in an attempt to pinpoint leaks in the HTW piping system between valve pits. Due to very loud background noise, the test results were inconclusive.

Additional field survey work planned:

> There are no additional field surveys planned for this project.

---

/kw

cc: T. Harper (FSEO)

RS&H

Reynolds, Smith and Hills, Inc.
*Architectural, Engineering, Planning and Environmental Services*

# Memorandum

**Date:** March 1, 1996

**To:** Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP ( Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

**From:** Carlos S. Warren, PhD, PE
Project Manager

**Subject:** Monthly Progress Report
Contract No. DACA01-94-0038/0002
Limited Energy Study - Hunter Army Airfield and Ft. Stewart HTW and CHW Distribution System

---

The following progress was made on the subject project during the month of February 1996:

1. A field investigation was performed on February 21. The goal was to use ultrasonic leak detection equipment to locate leaks in selected sections of the underground HTW distribution piping. The results were inconclusive due to very loud background noise in the HTW piping system.

2. Completed analysis of ECOs and submitted Interim Report.

Work planned for March 1996:

1. Await government review comments on the Interim Submittal.

2. Schedule review conference and presentation of Interim Report.

---

/kw

cc: T. Harper (FSEO)
W. Todd

**RS&H**
Reynolds, Smith and Hills, Inc.
*Architectural, Engineering, Planning and Environmental Services*

# Memorandum

**Date:** April 4, 1996

**To:** Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP ( Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

**From:** Carlos S. Warren, PhD, PE
Project Manager

**Subject:** Monthly Progress Report
Contract No. DACA01-94-0038/0002
Limited Energy Study - Hunter Army Airfield and Ft. Stewart HTW and CHW Distribution System

---

The following progress was made on the subject project during the month of March 1996:

No additional work was accomplished due to the Government review of the Interim Report.

Work planned for April 1996:

1. Await government review comments on the Interim Submittal.
2. Schedule review conference and presentation of Interim Report.

---

cc: W. Todd

# FACSIMILE TRANSMITTAL HEADER SHEET

For use of this form, see AR 25-11; the proponent agency is ODISC4

| COMMAND/ OFFICE | NAME/ OFFICE SYMBOL | OFFICE TELEPHONE NO. (AUTOVON/Comm.) | FAX NO. (AUTOVON/Comm.) |
|---|---|---|---|
| FROM: Savannah District | Rob Callahan CESAS-PM-MP | (912) 652-5246 | (912) 652-5442 |
| TO: R S & H | BILL TODD CARLOS WARREN | | |

| CLASSIFICATION | PRECEDENCE | NO. PAGES (Including this Header) | DATE-TIME | MONTH | YEAR | RELEASER'S SIGNATURE |
|---|---|---|---|---|---|---|
| N/A | | 17 | 15 | 4 | 96 | Robert A. Callahan |

REMARKS Following are the comments I've received on the Fort Stewart EEAP study. See you Wednesday.

*Space Below For Communications Center Use Only*

DA FORM 3918-R, JUL 90 DA FORM 3918-R, AUG 72 IS OBSOLETE V2.00

RS&H

# Memorandum

Reynolds, Smith and Hills, Inc.
*Architectural, Engineering, Planning and Environmental Services*

---

**Date:** April 29, 1996

**To:** Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP ( Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

**From:** Carlos S. Warren, PhD, PE
Project Manager

**Subject:** Monthly Progress Report
Contract No. DACA01-94-0038/0002
Limited Energy Study - Hunter Army Airfield and Ft. Stewart HTW and CHW Distribution System

---

The following progress was made on the subject project during the month of April 1996:

1. The Interim Report Review Conference was held at Ft. Stewart on 17 April 1996. Project findings and subsequent evaluation of the HTW line repair ECO was presented by RS&H. Comments were discussed and disposition of each comment was agreed to by conference participants.

2. Schedule for pre-final report submittal is 31 May 1996, 44 days after the Interim Review Conference.

Work planned for May 1996:

1. Complete and submit the pre-final report.

---

cc: W. Todd

**RS&H**

Reynolds, Smith and Hills, Inc.
*Architectural, Engineering, Planning and Environmental Services*

# Transmittal Letter

**To:** Attached Distribution List

**Date:** May 31, 1996

**Project:** Limited Energy Study HTW & CHW Distribution Sys. Fort Stewart & Hunter AAF

**Project Number:** 694-1331-002

**We Transmit:**

(X) Herewith ( ) Via Fax
( ) Under Separate Cover Via:
( ) In Accordance with Your Request
( ) Regular Mail (X) Overnight Mail ( ) Courier

**For Your:**

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(X) Review and Comment
( ) Use
( ) Signature

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| As per distribution list | 5-31-96 | Vol. III Cover, Title Page and Table of Contents |
| As per distribution list | N/A | Vol. III Valve Pit Summary Sheets - Section 1 |
| As per distribution list | N/A | Vol. III Mech. Room Summary Sheets - Section 2 |
| As per distribution list | N/A | Vol. III Leak Dections Survey Forms - Section 4 |

**Remarks:**

/kw

**Copies To:** C. Warren
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**Reynolds, Smith and Hills, Inc.**
4651 Salisbury Road
Jacksonville, Florida 32256
(904) 296-2000 Fax: (904) 279-2491
FL Cert. Nos. AAC001886•EB0005620•LCC000210

By: William T. Todd
William T. Todd, PE

Limited Energy Study
HTW and CHW Distribution Systems
Fort Stewart and Hunter AAF

PRE-FINAL REPORT

No. Copies

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|---|---|
| 2 | Commander<br>3rd Infantry Division and Fort Stewart<br>Attn: AFZP-DEV (Mr. Chet Scratzmeier)<br>Fort Stewart, GA 31314 |
| 1 | Commander<br>U. S. Army Forces Command<br>Attn: AFPI-ENO (Mr. Naresh Kapur)<br>Fort McPherson, GA 30330 |
| 2 | Savannah District Corps of Engineers<br>Attn: CESAS-PM-MR (Mr. Rob Callahan)<br>100 W. Oglethorpe Avenue<br>P. O. Box 889<br>Savannah, GA 31402-0889 |
| 1 | Mobile District, Corps of Engineers<br>Attn: CESAM-EN-DM (Mr. Tony Battaglia)<br>109 St. Joseph Street<br>Mobile, AL 36602 |

**RS&H**
Reynolds, Smith and Hills, Inc.
*Architectural, Engineering, Planning and Environmental Services*

# Memorandum

**Date:** June 5, 1996

**To:** Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

**From:** Carlos S. Warren, Ph.D., PE
Project Manager

**Subject:** Monthly Progress Report
Contract No. DACA01-94-0038/0002
Limited Energy Study - Hunter Army Airfield and Ft. Stewart HTW and CHW Distribution System

---

The following progress was made on the subject project during the month of May 1996:

- The Prefinal Report was completed and submitted on 31 May.

Work planned for June 1996:

- None planned; awaiting comments on the Prefinal Report.

---

CC: W. Todd

F:\FTS\MAY_RPT.DOC

**RS&H**
Reynolds, Smith and Hills, Inc.
*Architectural, Engineering, Planning and Environmental Services*

# Memorandum

**Date:** July 5, 1996

**To:** Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

**From:** Carlos S. Warren, Ph.D., PE
Project Manager

**Subject:** Monthly Progress Report
Contract No. DACA01-94-0038/0002
Limited Energy Study - Hunter Army Airfield and Ft. Stewart HTW and CHW Distribution System

---

The following progress was made on the subject project during the month of June 1996:

- No work was done on the project, as it is in the review process.

Work planned for July 1996:

- None planned; awaiting comments on the Prefinal Report.

---

CC: W. Todd
A. Battaglia, Mobile COE

F:\FTS\JUN_RPT.DOC

# Memorandum

RS&H
Reynolds, Smith and Hills, Inc.
*Architectural, Engineering, Planning and Environmental Services*

**Date:** August 5, 1996

**To:** Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

**From:** Carlos S. Warren, Ph.D., PE
Project Manager

**Subject:** Monthly Progress Report
Contract No. DACA01-94-0038/0002
Limited Energy Study - Hunter Army Airfield and Ft. Stewart HTW and CHW Distribution System

---

The following progress was made on the subject project during the month of July 1996:

- No work was done on the project, as it is in the review process.

Work planned for August 1996:

- None planned; awaiting comments on the Prefinal Report.

---

CC: W. Todd
A. Battaglia, Mobile COE

F:\FTS\JUL_RPT.DOC

# FACSIMILE TRANSMITTAL HEADER SHEET

For use of this form, see AR 25-11; the proponent agency is ODISC4

| COMMAND/ OFFICE | NAME/ OFFICE SYMBOL | OFFICE TELEPHONE NO. (AUTOVON/Comm.) | FAX NO. (AUTOVON/Comm.) |
|---|---|---|---|
| FROM: Savannah District | Rob Callahan CESAS-PM-MP | (912) 652-5246 | (912) 652-5442 |
| TO: RS & H | BILL TODD | | |

| CLASSIFICATION | PRECEDENCE | NO. PAGES (Including this Header) | DATE-TIME | MONTH | YEAR | RELEASER'S SIGNATURE |
|---|---|---|---|---|---|---|
| N/A | | 2 | 11 | 8 | 96 | Robert A. Callahan |

REMARKS Bill, following are ~~the~~ only comments I will be sending to you regarding the Ft. Stewart EEAP study. Please incorporate them into your final submittal. As a reminder, I'd like for you to re-read the Specific Instructions before you go final to

Space Below For Communications Center Use Only

DA FORM 3918-R, JUL 90 DA FORM 3918-R, AUG 72 IS OBSOLETE 12.00

insure compliance with all provisions. Thanks for your good work. Fred Cardo at Ft. Stewart is pleased with your work.

RAC

**RS&H**
Reynolds, Smith and Hills, Inc.
*Architectural, Engineering, Planning and Environmental Services*

# Memorandum

**Date:** September 4, 1996

**To:** Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

**From:** Carlos S. Warren, Ph.D., PE
Project Manager

**Subject:** Monthly Progress Report
Contract No. DACA01-94-0038/0002
Limited Energy Study - Hunter Army Airfield and Ft. Stewart HTW and CHW Distribution System

---

The following progress was made on the subject project during the month of August 1996:

- Comments on the Prefinal Report were received. The comments and responses were incorporated into the Final Report.

Work planned for September 1996:

- Completion of the Final Report.

- Submission of Final Report pages on September 6.

---

CC: W. Todd
A. Battaglia, Mobile COE

F:\FTS\AUG_RPT.DOC

RS&H

Reynolds, Smith and Hills, Inc.
*Architectural, Engineering, Planning and Environmental Services*

# Transmittal Letter

**To:** Attached Distribution List

**Date:** September 6, 1996

**Project:** Limited Energy Study HTW & CHW Distribution Sys. Fort Stewart & Hunter AAF

**Project Number:** 694-1331-002

**We Transmit:**

(X) Herewith ( ) Via Fax
( ) Under Separate Cover Via:
( ) In Accordance with Your Request
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**For Your:**

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(X) Review and Comment
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| As per distribution list | 9-6-96 | Vol. III-Insert and replacement pages |
| As per distribution list | 9-6-96 | Vol. ES-Executive Summary |

**Remarks:**

/kw
**Copies To:** C. Warren
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**Reynolds, Smith and Hills, Inc.**
4651 Salisbury Road
Jacksonville, Florida 32256
(904) 296-2000 Fax: (904) 279-2491
FL Cert. Nos. AAC001886•EB0005620•LCC000210


By: William T. Todd

William T. Todd, PE

Limited Energy Study
HTW and CHW Distribution Systems
Fort Stewart and Hunter AAF

FINAL REPORT

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| 1 | Commander<br>U. S. Army Forces Command<br>Attn: AFPI-ENO (Mr. Naresh Kapur)<br>Fort McPherson, GA 30330 |
| 2 | Savannah District Corps of Engineers<br>Attn: CESAS-PM-MR (Mr. Rob Callahan)<br>100 W. Oglethorpe Avenue<br>P. O. Box 889<br>Savannah, GA 31402-0889 |
| 1 | Mobile District, Corps of Engineers<br>Attn: CESAM-EN-DM (Mr. Tony Battaglia)<br>109 St. Joseph Street<br>Mobile, AL 36602 |
| 1 (ES only) | Commander<br>U. S. Army Engineer Division, South Atlantic<br>Attn: CESAD-EN-TE (Mr. Baggette)<br>77 Forsyth Street, SW<br>Atlanta, GA 30335-6801 |
| 1 (ES only) | Commander<br>U. S. Army Corps of Engineers<br>Attn: CEMP-ET (Mr. Gentil)<br>20 Massachusetts Avenue, NW<br>Washington, DC 20314-1000 |
| 1 (ES only) | Commander<br>U. S. Army Logistics Evaluation Agency<br>Attn: LOEA-PL (Mr. Keath)<br>New Cumberland Army Depot<br>New Cumberland, PA 17070-5007 |

# A.10 RECORDS ANALYSIS AND SITE SURVEY PLAN

Limited Energy Study
High Temperature and Chilled
Water Distribution Systems
Fort Stewart and Hunter AAF

# Records Analysis and Site Survey Plan

August 28, 1995
Contract # DACA01-94-D-0038
Project # 694-1331-002

RS&H
Reynolds, Smith and Hills, Inc.
*Architectural, Engineering, Planning and Environmental Services*

A.10-1

**Limited Energy Study**
**High Temperature and Chilled Water**
**Distribution Systems**

**Fort Stewart and Hunter Army Airfield**

**Records Analysis and**
**Site Survey Plan**

Savannah District
Corps of Engineers

Contract No. DACA01-94-D-0038
Delivery Order #0002


Reynolds, Smith and Hills, Inc.
Jacksonville, Florida

Carlos S. Warren, PhD, PE
Project Manager

William T. Todd
William T. Todd, PE
Field Survey Manager


August 28, 1995

6941331002

A.10-2

**RECORDS ANALYSIS AND**
**SITE SURVEY PLAN**
**FORT STEWART AND HUNTER ARMY AIRFIELD**
**HTW AND CHW DISTRIBUTION SYSTEMS**

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A. 10-3

RECORDS ANALYSIS AND SITE SURVEY PLAN
FORT STEWART AND HUNTER ARMY AIRFIELD
HTW AND CHW DISTRIBUTION SYSTEMS

# 1.0 RECOMMENDATIONS FOR THE HTW AND CHW SYSTEMS AT HUNTER AAF

## 1.1 HIGH TEMPERATURE WATER AND STEAM SYSTEMS

**Estimated HTW System Losses**

Makeup water volume data for the HTW and steam distribution systems for July 1994 through June 1995 were obtained from the Central Energy Plant (CEP) and Pinwheel Barracks Plant (PBP) operating logs. The total makeup water flow rate for this period was 333,857 gallons, or approximately 916 gallons per day (gpd). The PBP steam distribution system losses represent 77 percent (706 gpd) of the total and the CEP HTW system losses make up the remaining 23 percent (210 gpd). Assuming the blowdown is about equal to the chemical feed system input, the makeup water flow rate should be roughly equal to the amount of leaks from the distribution system. Based on an estimated total system volume of 1,900 gallons for the CEP HTW system, the estimated HTW leakage rate is approximately 11 percent of the total HTW system volume per day. The PBP distributes 50 psi steam. The losses from the PBP system are higher than the CEP system losses as would be expected for a steam distribution system.

The total estimated cost of losses from the CEP and PBP HTW distribution systems is approximately $2,120 per year. This value includes the cost for fuel oil used by the boilers (443 MBtu/Year & $1,925/Year); distribution system pumps (314 kWh/Year & $15/Year); and the cost of raw water produced at Hunter AAF ($180/Year). The cost for chemical treatment of the HTW system leaks is assumed to be negligible. The boiler energy use and cost assumes an average boiler efficiency of 75 percent.

**Recommendations**

The estimated 11 percent losses for the CEP distribution system are high for a closed loop system. However, the total costs of losses from the CEP HTW system and the PBP steam system are less than one percent of the total operating costs of these systems. Therefore, we recommend no further studies be undertaken for the HTW distribution systems from the CEP and the PBP.

## 1.2 CHILLED WATER DISTRIBUTION SYSTEMS

**Estimated CHW System Losses**

The chilled water makeup is not metered at either the CEP or the PBP. The Hunter AAF DPW staff said that their chilled water chemical treatment contractor has indicated a leakage problem with both the CEP and the PBP chilled water distribution systems. Conversations with the chemical treatment contractor revealed an estimate of thousands of gallons per week being lost form each of these two distribution systems and that there has been a leakage problem for over eight years. The contractor samples the CHW system water and adds chemicals each month. The chemicals have vanished between monthly samples. The actual CHW system losses cannot be accurately determined since there is no trace of the chemicals left.

The total chilled water system capacities were estimated to be about 4,700 gallons for the PBP and 4,200 gallons for the CEP. Assuming a conservative estimate of the equivalent of one system volume is lost each month, the CHW losses would amount to over 2,000 gallons per week. This represents a leakage rate of three percent of the total system volume per day. The actual losses could be much higher.

**Recommendations**

There is obviously a problem with these systems, however it can not be quantified without some type of metering effort. Installing new permanent water meters on the CHW system makeup water lines at the PBP and the CEP would cost approximately $500 and $200, respectively. The cost to have RS&H temporarily meter these systems would be much more than the $700 the Army would pay to have a mechanical contractor install the two new permanent meters.

We recommend that permanent flow meters be installed on the chilled water makeup lines at the CEP and the PBP. These meters should be read and the data tabulated on a monthly basis. The new information could be analyzed after three to four months of data have been observed and recorded. Recommendations for further action could be made at that time.

## 2.0 RECOMMENDATIONS FOR THE CHW SYSTEM AT FORT STEWART

**Estimated CHW System Losses**

Makeup water volume data for July 1994 through June 1995 for the chilled water distribution system were obtained from the CEP operating logs. The total makeup water flow rate for this period was 1,106,710 gallons, or approximately 3000 gallons per day. This makeup water flow rate should be roughly equal to the amount of chilled water leaks in the distribution system. The total volume of water in the CHW distribution system was estimated to be about 600,000 gallons. Based on the total estimated volume of chilled water, the estimated chilled water leakage is approximately 0.5 percent of the total chilled water system volume per day.

The total estimated cost of the chilled water system losses is about $1,250 per year. This value includes the cost for energy used by the chillers, condenser pumps and cooling tower fans (11,310 kWh/Year & $566/Year); distribution system pumps (1,310 kWh/Year & $66/Year); and the cost of raw water produced at Fort Stewart ($615/Year). There is no chemical treatment used for the chilled water distribution system. The chiller energy use and cost assumes all of the chilled water is produced by electric centrifugal chillers, a worst case scenario since electricity is the most expensive fuel utilized at Fort Stewart.

**Recommendations**

The amount of the CHW distribution system losses is less than one percent of the total CHW system volume per day. Therefore, we recommend no further studies be undertaken for the Fort Stewart CHW distribution system.

## 3.0 FORT STEWART HTW DISTRIBUTION SYSTEM

**Estimated HTW System Losses**

Makeup water volume data for July 1994 through June 1995 for the HTW distribution system were obtained from the Central Energy Plant (CEP) operating logs. The total metered makeup water flow for this period was 4,029,636 gallons, or approximately 11,048 gallons per day. Boiler blowdown and flow rates for the three unmetered chemical feed systems were estimated based on conversations with CEP operators. The total estimated losses for the HTW system are approximately 5,809,700 gallons per year. This estimate assumes the total makeup water less the boiler blowdown is roughly equal to the amount of leaks from the HTW distribution system. Based on an estimated total HTW system volume of 218,000 gallons, the estimated HTW leakage represents approximately five percent of the total HTW system volume per day. Typical closed loop distribution systems have a makeup requirement of one-fourth to one-half of one percent of the total system volume in a given 24 hour period.

The total estimated cost of losses from the HTW distribution system is $29,290 per year. This value includes the cost for wood chips, fuel oil and natural gas used by the boilers (22,100 MBtu/Year & $25,640/Year); distribution system pumps (8,400 kWh/Year & $420/Year); and the cost of raw water produced at Fort Stewart ($3,230/Year). The cost for chemical treatment of the HTW system leaks is assumed to be negligible compared to these other values. The calculated boiler energy use and cost assumes an average boiler efficiency of 68 percent.

## 4.0 FIELD INVESTIGATION PLAN

The field investigation will be accomplished in three phases. The objective of the first phase is to determine as accurately as possible how much is leaking from the HTW system. This will be accomplished by first surveying the Central Energy Plant and Satellite Energy Plants, and metering and estimating the mass flows into and out of the HTW system. The second step of the first phase is to estimate the amount of HTW leaking within the hot water generators in the buildings served by the HTW system.

Valve pits, drain pits and valve boxes will be inspected during the second phase of the field survey effort. This survey will indicate the location of leaking valves and fittings and also isolate sections of the underground distribution piping where leaks may be occurring. We will also attempt to quantify the amount of HTW leaking from the various valves and fittings.

The final phase of the field investigation will attempt to pinpoint and quantify the leaks within the underground HTW distribution system piping. The detailed field investigation plans and schedule of events are presented in the following pages.

### 4.1 CENTRAL ENERGY PLANT (CEP)

1. Measure the flow of makeup water to the HTW system.

   The amount of makeup water added to the HTW system is a direct indication of how much HTW is leaking out of the system.

   The flows will be measured using a non-intrusive, clamp-on, transient-time ultrasonic flow meter. If any pipe insulation must be removed for these measurements, we will request that the Fort Stewart DPW perform the removal and reinstallation.

   We will make sure the makeup water flow measurements include the water softeners, two chemical feed systems and the phosphate tank. It appears that the metered flow only includes the water that goes through the water softeners.

   There is a 3 inch raw water line that should include all of these systems except perhaps the phosphate tank. The 3 inch line splits with a 2.5 inch line going to the water softeners and two 3/4 inch lines going to the chemical feed systems. The 2.5 inch makeup water line from the

water softeners and the 3/4 inch makeup water line from the sulphur tank feed into the deaerator. The 3/4 inch makeup water line from the ph control tank feeds into all three cascade heaters.

There is a 1/2 inch line (rated at 5 g.p.m. on the record drawings) from the phosphate tank that feeds into the 4 inch feed water line to the wood fired boiler.

2. <u>Measure or estimate the continuous and intermittent blowdown from all boilers and cascade heaters.</u>

The amount of blowdown water must be subtracted from the amount of makeup water to determine the actual HTW distribution system losses.

The flows will be measured using a non-intrusive, clamp-on, transient-time ultrasonic flow meter. If any pipe insulation must be removed for these measurements, we will request that the Fort Stewart DPW perform the removal and reinstallation.

There is a 4 inch line from the intermittent blowdown tank (for the wood fired boiler) rated at 165 g.p.m. on the record drawings.

Each of the three cascade heaters has a 1.5 inch blowdown line that feeds into a 3 inch header. The 3 inch blowdown header goes to a blowdown tank that may or may not be the same tank mentioned above. The record drawings indicate a blowdown tank located outside the south corner of the CEP. It is not clear from the drawings but this line may be part of the condensate return system.

3. <u>Estimate the total flow of HTW through the supply distribution system.</u>

The total HTW flow value will be used to determine what percentage of the total flow is lost by leaks in the distribution system.

Read and record the pressures shown on the pressure gages before and after the supply pumps for all three HTW distribution zones. Measure and record the voltage and current for each HTW pump motor. Record the data from the nameplates on the pumps and pump motors.

4. <u>Obtain copies of the boiler water, boiler feed water and HTW supply water analysis reports.</u> These reports will be used to verify the boiler blowdown estimates and also to compare with the samples taken from the various domestic hot water systems in the buildings served by the HTW system. The comparison will help determine if any of the heat exchangers in the hot water generators have failed. Refer to section on survey of mechanical equipment rooms for additional information.

We will also comment on the chemical makeup of the HTW system water and weather it is appropriate to prevent corrosion or pitting of the HTW distribution system piping.

**<u>Personnel Assignments</u>**

1 - Engineer

1 - Metering Subcontractor

## 4.2 SATELLITE ENERGY PLANT (SEP)

1. Measure or estimate the flow of makeup water to the SEP HTW distribution system.
The amount of makeup water added to the SEP HTW system will provide a direct indication of how much HTW is leaking out of this part of the system.

There is no direct fresh or treated makeup water feed to the SEP HTW distribution system. The water level in the two SEP cascade heaters is manually checked three times per day (once each shift). When the water level in the cascade heaters drops below a certain value, the CEP operators use the HTW system return pipes to "back fill" the SEP cascade heaters. We will determine how often these systems need to be filled and approximately how much water is "added".

2. Measure or estimate the blowdown from the two cascade heaters.
The amount of blowdown water must be subtracted from the amount of makeup water to determine the actual HTW distribution system losses.

Each of the three cascade heaters in the CEP has a 1.5 inch blowdown line. Assuming the two cascade heaters in the SEP also have blowdown lines, we will determine the frequency and duration of use for these blowdown lines.

3. Estimate the total flow of HTW through the SEP supply distribution system.
The total HTW flow from the SEP will be used to determine what percentage of the total HTW flow is lost by leaks in this distribution system.

Read and record the pressures shown on the pressure gages before and after the supply pump. Measure and record the voltage and current for the HTW pump motor. Record the data from the nameplates on the pumps and pump motors.

**Personnel Assignments**

1 - Engineer

1 - Metering Subcontractor

## 4.3 BUILDING HOT WATER GENERATORS

1. Obtain a sample of the domestic hot water from the building for testing.

   These samples will be analyzed by a laboratory and the analysis will be compared to the analysis of the HTW and the Fort Stewart potable water supply. If chemicals that are usually only present in the HTW are found in the domestic hot water, then the heat exchanger has probably failed and is leaking. Hot water temperatures will also be measured to indicate a leaking heat exchanger or failed controls/valves.

   The domestic hot water source will be allowed to flow for a sufficient time prior to sampling to ensure the sample is not diluted with potable cold water. The samples will be taken during a time that the building hot water system is not being heavily used (9:00 AM to 3:00 PM).

2. Survey Hot Water Generators.

   Those hot water generators that have leaking HTW heat exchangers will be surveyed to determine the leakage rate and volume. The hot water generators will be isolated by cut-off valves and tank overflows measured.

**Personnel Assignments**

| **Crew No. 1:** | **Crew No. 2:** |
|---|---|
| 1 - Engineer | 1 - Engineer |
| 1 - Technician | 1 - Technician |

## 4.4 VALVE PITS, DRAIN PITS AND VALVE BOXES

**Valve Pits**

There are approximately 60 valve pits located along the HTW supply and return lines.

1. Check for HTW leaks around the valve stems, flanges and fittings for all of the valves and fittings in the valve pit. Estimate the volume of flow from each leak found.

   Valves and fittings typically found in the valve pits are listed below.

   a. Check globe valves on all HTW mains and take offs.

   b. Check drain valves on all mains. There are two globe valves for each HTW main valve.

   c. Check valves and fittings on all line vents. There are two globe valves and an air bottle on each vent line.

2. Check for steam flowing from the conduit vents on HTW lines where they enter and exit the pit.

3. If there is standing water in the bottom of the pit, make a note indicating that the pump is not working.

**Drain Pits**

The drain pits are located at low points along the main HTW supply and return lines.

1. Check for HTW leaks around the valve stems, flanges and fittings for all of the valves and fittings in the drain pits. Estimate the volume of flow from each leak found.

   Typically, there is one globe valve on each HTW supply and return line.

2. Check for steam flowing from the conduit vents on HTW lines where they enter and exit the pit.

3. If there is standing water in the bottom of the pit, make a note indicating that the pump is not working.

## Valve Boxes

The valve boxes are located at high points along the main HTW supply and return lines.

1. <u>Check for HTW leaks around the valve stems, flanges and fittings for all of the valves and fittings in the valve boxes. Estimate the volume of flow from each leak found.</u>
   There are typically two HTW risers in each valve box and two globe valves and one air bottle on each riser.

## Personnel Assignments

**Crew No. 1:**

1 - Engineer

1 - Technician

**Crew No. 2:**

1 - Engineer

1 - Technician

## 4.5 UNDERGROUND HTW DISTRIBUTION SYSTEM PIPING

Information obtained during the survey of the valve pits will be used to isolate sections of the HTW distribution system that is suspected of having leaks. Once these sections of piping have been identified, an infrared thermometer will be used to locate "hot spots" at ground level along the HTW distribution piping. The hot spots will indicate areas of the piping where the pipe insulation has become saturated and is no longer effective. There are two possible causes of the hot spots. Either the outer conduit has failed and the insulation has become soaked with groundwater, or a leak in the pipe has caused the insulation to become saturated with HTW.

The sections of HTW piping suspected of having leaks will be systematically surveyed with a electronic gas and liquid leak detector in an effort to determine as accurately as possible the location of all distribution system leaks. The leaking HTW will more than likely flash to steam as it escapes from the pipe. The ultrasonic range of the leak detector will be used to locate these gaseous type "steam" leaks. The sonic range can be used to detect liquid leaks if for some reason the HTW leaks remain in the liquid form.

**Personnel Assignments**

**Crew No. 1:**

1 - Engineer

1 - Technician

**Crew No. 2:**

1 - Engineer

1 - Technician

## 5.0 SCHEDULE OF EVENTS

| Week Ending | Tasks to be Accomplished |
|---|---|
| Aug 04, 1995 | - Obtain data, drawings and maintenance records for the HTW and CHW systems at Fort Stewart and Hunter AAF.<br>- Conduct interviews with DPW Personnel at Fort Stewart and Hunter AAF.<br>- Preliminary survey of CEP, valve pits and mechanical equipment rooms at Fort Stewart. |
| Sep 15, 1995 | - Locate HTW makeup water, chemical feed and blowdown pipes to be metered and determine if pipe insulation removal is required.<br>- Obtain copies of recent HTW sample analysis reports from the CEP and potable water analysis reports from the water plant.<br>- Progress report to FESO and Savannah COE. |
| Oct 27, 1995 | - Survey the CEP. Meter HTW makeup water, chemical feed water and blowdown water. Record pump and motor data.<br>- Survey the SEP. Meter HTW makeup water and blowdown water. Record pump and motor data.<br>- Water samples taken in buildings.<br>- Progress report to FESO and Savannah COE. |
| Nov 10, 1995 | - Survey valve pits, drain pits and valve boxes.<br>- Progress report to FESO and Savannah COE. |
| Dec 15, 1995 | - Survey HTW supply and return distribution lines.<br>- Survey leaking hot water generators.<br>- Progress report to FESO and Savannah COE. |

# 6.0 SUPPORTING DATA AND CALCULATIONS

## HTW System Losses

Make up water data for the Pinwheel Barracks and the central energy plant were tabulated from boiler logs for 7/94 through 6/95. Assuming the makeup water is equal to the distribution system losses less the amount of boiler blowdown, the

| | | | |
|---|---|---|---|
| Make up Water | 916 | gal/day | (avg) |
| Chemical Feed | + 30 | gal/day | estimate |
| Blowdown | − 30 | gal/day | estimate |
| System Losses = | 916 | gal/day | (avg) |
| | 0.6 | gal/min | (avg) |

Energy Loss:

$$257{,}332 \ \text{gal/yr} \times 8.345 \frac{\text{lb}}{\text{gal}} \times 1 \frac{\text{Btu}}{\text{lb}\,°\text{F}} \times (155-70)\,°\text{F} = 182.5 \frac{\text{MBtu}}{\text{YR}} \quad (\text{PB})$$

$$76{,}525 \ \text{"} \times \text{"} \times \text{"} \times (305-70)\,°\text{F} = 150.1 \frac{\text{MBtu}}{\text{YR}} \quad (\text{CEP})$$

$$\text{Total Energy Loss} = 182.5 + 150.1 = \underline{332.6 \ \text{MBtu/YR}}$$

$$\text{Cost: } \$0.6124/\text{gallon} \times \frac{1 \text{ gallon}}{0.141 \text{ MBtu}} = \$4.34/\text{MBtu}$$

$$332.6 \frac{\text{MBtu}}{\text{YR}} \times \frac{1}{0.75}\text{eff} \times \$4.34/\text{MBtu} = \underline{\$1{,}925/\text{Year}}$$

## Pumping Cost

$$\text{Pump BHP} = \frac{\text{GPM} \times \text{Head}}{3960 \times \text{eff}} = \frac{0.6 \times 200\text{ft}^{*}}{3960 \times 0.70} = 0.04 \text{ BHP}$$

 * From record drawings

Pumping cost - continued

$$0.04\ BHP \times 0.746\ \frac{KW}{HP} \div 0.9\ {}^{motor}_{eff} \times 8760\ \frac{hr}{yr} = \underline{314\ \frac{kwh}{yr}}$$

$$Cost = 314\ \frac{kwh}{yr} \times \$0.048/kwh = \underline{\$15/year}$$

Water Cost

$$886\ \frac{gal}{day} \times 365\ \frac{day}{yr} \times \$0.56/1000\ gal = \underline{\$181/year}$$

Total Cost

Heating Fuel + Pumping cost + Water cost = Total

$$\text{Total Cost} = \$1925 + \$15 + \$180 \approx \underline{\$2,120/year}$$

Percent Losses (CEP only)

$$\frac{210\ gal/day\ makeup}{1900\ gallons\ volume} \times 100 = \underline{\underline{11\%}}$$

Hunter AAF - Central Energy Plant & Pinwheel Barracks
Boiler Makeup Water
Filename: HAAF-HTW.WQ1

| Mo | Yr | PB (2) Makeup Gal(1) | Makeup Gal/Day | CEP (3) Makeup Gal(1) | Makeup Gal/Day | Total Makeup Gal(1) | Makeup Gal/Day |
|---|---|---|---|---|---|---|---|
| 7 | 94 | 18660 | 602 | 4010 | 129 | 22670 | 731 |
| 8 | 94 | 17320 | 559 | 3640 | 117 | 20960 | 676 |
| 9 | 94 | 15030 | 501 | 3320 | 111 | 18350 | 612 |
| 10 | 94 | 15460 | 499 | 7478 | 241 | 22938 | 740 |
| 11 | 94 | 18870 | 629 | 10950 | 365 | 29820 | 994 |
| 12 | 94 | 17950 | 579 | 10310 | 333 | 28260 | 912 |
| 1 | 95 | 23840 | 769 | 6900 | 223 | 30740 | 992 |
| 2 | 95 | 23499 | 839 | 5730 | 205 | 29229 | 1044 |
| 3 | 95 | 26440 | 853 | 5750 | 185 | 32190 | 1038 |
| 4 | 95 | 23750 | 792 | 6280 | 209 | 30030 | 1001 |
| 5 | 95 | 28873 | 931 | 6222 | 201 | 35095 | 1132 |
| 6 | 95 | 27640 | 921 | 5935 | 198 | 33575 | 1119 |
| AVG | | 21444 | 706 | 6377 | 210 | 27821 | 916 |
| TOTALS | | 257332 | | 76525 | | 333857 | |

(1) Source is Hunter AAF Operating Logs.
(2) PB - Pinwheel Barracks Energy Plant.
(3) CEP - Central Energy Plant.

Estimate Distribution System Losses:

| | | |
|---|---|---|
| | 916 | gpd, avg make-up water |
| - | 30 | gpd, avg blowdown water * |
| | 886 | gpd, avg dist sys losses |

* Boiler blowdown estimate:

| | | |
|---|---|---|
| | 300 | gpm, estimate 150 gpm for 3 inch pipe x 2 pipes |
| x | 0.033 | min/blowdown, 2 seconds per blowdown |
| | 10 | gal/blowdown |
| x | 3 | blowdowns/day, assumed 3 blowdowns per day |
| | 30 | gal/day |

Hunter AAF - Central Energy Plant
Estimate of HTW System Losses
Filename: H-HTW-CP.WQ1

| Pipe Service | Bldg. Served | Pipe Dia. (in) | Linear Feet | Pipe Vol. (CF) | Pipe Vol. (Gal) |
|---|---|---|---|---|---|
| CWS | All (Plant) | 6 | 150 | 29.5 | 220 |
| CWR | All (Plant) | 6 | 200 | 39.3 | 294 |
| CWS | All (main) | 6 | 26 | 5.1 | 38 |
| CWR | All (main) | 6 | 26 | 5.1 | 38 |
| CWS | All (main) | 4 | 255 | 22.3 | 166 |
| CWR | All (main) | 4 | 255 | 22.3 | 166 |
| CWS | All (main) | 2 | 368 | 8.0 | 60 |
| CWR | All (main) | 2 | 368 | 8.0 | 60 |
| CWS | 1-S Bldg. | 1 | 154 | 0.8 | 6 |
| CWR | 1-S Bldg. | 1 | 154 | 0.8 | 6 |
| CWS | 2-S Bldg. | 1 | 98 | 0.5 | 4 |
| CWR | 2-S Bldg. | 1 | 98 | 0.5 | 4 |
| TOTALS | | | 2152 | | 1062 |

| | | |
|---|---|---|
| Expansion Tanks, etc | 500 | |
| Two Story Building Piping (estimate) | 200 | |
| One Story Building Piping (estimate) | 125 | |
| Estimated System Volume | 1887 | Gallons |

| | | |
|---|---|---|
| 1.0% of total volume lost per day = | 19 | Gal/Day |
| 19 gal/day x 30 day/mo = | 566 | Gal/Mo. |
| 19 gpd / 1440 min/day = | 0.01 | Gal/Min |
| 100.0% of total volume lost per day = | 1887 | Gal/Day |
| 1887 gal/day x 30 day/mo = | 56610 | Gal/Mo. |
| 1887 gpd / 1440 min/day = | 1.31 | Gal/Min |

Hunter Army Air Field
Fuel Oil Consumption
Filename: HAAF-OIL.WQ1

| Month | CEP | PBP | Total |
|---|---|---|---|
| Jul | 3730 | 21157 | 24887 |
| Aug | 3880 | 17978 | 21858 |
| Sep | 3460 | 17244 | 20704 |
| Oct | 5454 | 8611 | 14065 |
| Nov | 6421 | 13004 | 19425 |
| Dec | 10040 | 28962 | 39002 |
| Jan | 8470 | 43829 | 52299 |
| Feb | 8455 | 44122 | 52577 |
| Mar | 6630 | 44965 | 51595 |
| Apr | 5379 | 29115 | 34494 |
| May | 4580 | 21693 | 26273 |
| Jun | 3850 | 23250 | 27100 |
| Gal/Yr | 70349 | 313930 | 384279 |
| Mbtu/Y | 9919 | 44264 | 54183 |
| $/Yr | 43082 | 192251 | 235332 |

**RS&H**®

# Telephone Call Confirmation

912-352-5519

Project Number 694 1331 002

Local ______ L.D. ______ Placed ______ Rec'd ______ Date 8-17-95

Conversed with Troy Noonan Of Hunter AAF Boiler Plants

Regarding Blowdown estimate for CEP and PB boilers

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They have no set schedule for boiler blowdown. The operator that samples the water will manually blowdown the boiler as needed to adjust the chemical makeup of the water.

The blowdown pipe is approximately 3 inches in diameter. The duration of each blowdown is 2 seconds.

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Distribution:

**RS&H**

SUBJECT HUNTER AAF
CHW DIST. SYSTEM
DESIGNER WTT
CHECKER

AEP NO
SHEET 1 OF
DATE 8-22-95
DATE

According to the chemical treatment contractor, at least one complete volume must be leaking out each month.

CEP Volume ≈ 4150 gal.
PBP Volume ≈ 4670 gal.

Total = 8,820 gal.

8,820 gal / 30 days ≈ 294 gal/day

$$\text{Percent losses} \approx \frac{294 \frac{\text{gal}}{\text{day}} \text{ makeup est.}}{8{,}820 \text{ gal Volume est.}} \times 100 = \underline{3\% \text{ minimum}}$$

RS&H

SUBJECT HUNTER AAF
CHW DIST. SYSTEM
DESIGNER WTT
CHECKER

AEP NO
SHEET 2 OF
DATE 8-21-95
DATE

SYSTEM INFORMATION :

PBP; From record drawings, Chiller cap = 600 tons

1060 gpm, 90 ft head, 80% eff.

Pump motor design = 40 hp

$$\text{Pump BHP} = \frac{1060 \times 90}{3960 \times 0.8} = 30 \text{ BHP}$$

Make up water pipe dia. = 1", meter cost ≈ $200

CEP; from record drawings, Chiller cap. = 200 tons

342 gpm, 45 ft head, 78% eff.

Pump motor design = 20 hp

$$\text{Pump BHP} = \frac{342 \times 45}{3960 \times 0.78} = 5 \text{ BHP}$$

Makeup water pipe dia. = 1½", meter cost ≈ $500

Hunter AAF - Central Energy Plant
Estimate of Chilled Water Losses
Filename: H-CHW-CP.WQ1

| Pipe Service | Bldg. Served | Pipe Dia. (in) | Linear Feet | Pipe Vol. (CF) | Pipe Vol. (Gal) |
|---|---|---|---|---|---|
| CWS | All (Plant) | 8 | 145 | 50.6 | 379 |
| CWR | All (Plant) | 8 | 90 | 31.4 | 235 |
| CWS | All (main) | 8 | 285 | 99.5 | 744 |
| CWR | All (main) | 8 | 285 | 99.5 | 744 |
| CWS | All (main) | 6 | 338 | 66.4 | 496 |
| CWR | All (main) | 6 | 338 | 66.4 | 496 |
| CWS | 1-S Bldg. | 4 | 154 | 13.4 | 101 |
| CWR | 1-S Bldg. | 4 | 154 | 13.4 | 101 |
| CWS | 2-S Bldg. | 3 | 98 | 4.8 | 36 |
| CWR | 2-S Bldg. | 3 | 98 | 4.8 | 36 |
| TOTALS | | | 1985 | | 3368 |

| | | |
|---|---|---|
| Expansion Tank | 132 | |
| Two Story Building Piping (estimate) | 400 | |
| One Story Building Piping (estimate) | 250 | |
| Estimated System Volume | 4150 | Gallons |

1.0% of total volume lost per day = 42 Gal/Day

42 gal/day x 30 day/mo = 1245 Gal/Mo.

42 gpd / 1440 min/day = 0.03 Gal/Min

100.0% of total volume lost per day = 4150 Gal/Day

4150 gal/day x 30 day/mo = 124500 Gal/Mo.

4150 gpd / 1440 min/day = 2.88 Gal/Min

Hunter AAF - Pinwheel Barracks Chiller Plant
Estimate of Chilled Water Losses
Filename: H-CHW-PB.WQ1

| Pipe Service | Bldg. Served | Pipe Dia. (in) | Linear Feet | Pipe Vol. (CF) | Pipe Vol. (Gal) |
|---|---|---|---|---|---|
| CWS | All (Plant) | 8 | 67 | 23.4 | 175 |
| CWR | All (Plant) | 8 | 85 | 29.7 | 222 |
| CWS | All (main) | 8 | 218 | 76.1 | 569 |
| CWR | All (main) | 8 | 218 | 76.1 | 569 |
| CWS | 1275 | 6 | 308 | 60.5 | 452 |
| CWR | 1275 | 6 | 308 | 60.5 | 452 |
| CWS | 1276 | 4 | 274 | 23.9 | 179 |
| CWR | 1276 | 4 | 274 | 23.9 | 179 |
| CWS | 1277 | 6 | 304 | 59.7 | 447 |
| CWR | 1277 | 6 | 304 | 59.7 | 447 |
| TOTALS | | | 2360 | | 3691 |

| | | |
|---|---|---|
| Expansion Tank | 80 | |
| Building 1275 Piping (estimate) | 300 | |
| Building 1276 Piping (estimate) | 300 | |
| Building 1277 Piping (estimate) | 300 | |
| Estimated System Volume | 4671 | Gallons |

| | | |
|---|---|---|
| 1.0% of volume lost per day = | 47 | Gal/Day |
| 47 gal/day x 30 day/mo = | 1401 | Gal/Mo. |
| 47 gpd / 1440 min/day = | 0.03 | Gal/Min |
| 100.0% of volume lost per day = | 4671 | Gal/Day |
| 4671 gal/day x 30 day/mo = | 140130 | Gal/Mo. |
| 4671 gpd / 1440 min/day = | 3.24 | Gal/Min |

**RS&H**®

**Telephone Call Confirmation**

800-343-0538

Project Number 694 1331 002

Local ______ L.D. Atlanta Placed ______ Rec'd ______ Date 8-17-95

Conversed with Frank Lloyd Of Technical Specialties Corp.

Regarding Hunter AAF Chilled Water Systems at CEP & PB

---

Frank estimates "thousands of gallons per week" are lost from each chilled water system. They add chemicals to the systems and when a sample is taken the following month there is no trace of the chemicals. They can estimate the volume lost by taking samples more often and tracking the chemical depletion. Frank estimates the cost of installing a new permanent water meter is between $200 (for a 1" pipe) and $600 (for a 3" pipe). He called the water leaks in the CEP and PB a "serious loss". In addition to the costs of leaks, the loss of chemicals creates a corrosion problem. These systems have been leaking for over 8 years. The volume in a system is estimated at 7-9 gallons/ton. Cost for chemical treatment is $4 - $6 per ton (for systems > 1000 tons).

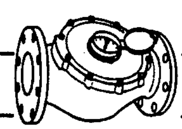
Distribution:

# 153 | Plumbing Appliances



## 153 100 | Water Appliances

| | | | CREW | DAILY OUTPUT | MAN-HOURS | UNIT | 1995 BARE COSTS MAT. | LABOR | EQUIP. | TOTAL | TOTAL INCL O&P | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 130 | 3060 | 140 gal., 24" diam. x 80" LOA | 1 Plum | 6 | 1.333 | Ea. | 2,125 | 39 | | 2,164 | 2,375 | 130 |
| | 3080 | 225 gal., 30" diam. x 78" LOA | | 4 | 2 | | 2,050 | 58.50 | | 2,108.50 | 2,350 | |
| | 3100 | 325 gal., 36" diam. x 81" LOA | | 3 | 2.667 | | 2,500 | 78 | | 2,578 | 2,875 | |
| | 3120 | 460 gal., 42" diam. x 84" LOA | Q-1 | 4 | 4 | | 3,450 | 106 | | 3,556 | 3,950 | |
| | 3140 | 605 gal., 48" diam. x 87" LOA | | 3 | 5.333 | | 4,775 | 141 | | 4,916 | 5,475 | |
| | 3160 | 740 gal., 54" diam. x 91" LOA | | 3 | 5.333 | | 5,700 | 141 | | 5,841 | 6,500 | |
| | 3180 | 940 gal., 60" diam. x 93" LOA | | 2.50 | 6.400 | | 6,550 | 169 | | 6,719 | 7,450 | |
| | 3200 | 1330 gal., 66" diam. x 107" LOA | | 2 | 8 | | 8,750 | 211 | | 8,961 | 9,950 | |
| | 3220 | 1615 gal., 72" diam. x 110" LOA | | 1.50 | 10.667 | | 10,100 | 281 | | 10,381 | 11,500 | |
| | 3240 | 2285 gal., 84" diam. x 128" LOA | | 1 | 16 | | 15,100 | 420 | | 15,520 | 17,200 | |
| | 3260 | 3440 gal., 96" diam. x 157" LOA | Q-2 | 1.50 | 16 | | 22,400 | 440 | | 22,840 | 25,300 | |
| 160 | 0010 | WATER SUPPLY METERS | | | | | | | | | | 160 |
| | 1000 | Detector, serves dual systems such as fire and domestic or | | | | | | | | | | |
| | 1020 | process water, wide range cap., UL and FM approved | | | | | | | | | | |
| | 1100 | 3" mainline x 2" by-pass, 400 GPM | Q-1 | 3.60 | 4.444 | Ea. | 5,825 | 117 | | 5,942 | 6,600 | |
| | 1140 | 4" mainline x 2" by-pass, 700 GPM | " | 2.50 | 6.400 | | 6,275 | 169 | | 6,444 | 7,150 | |
| | 1180 | 6" mainline x 3" by-pass, 1600 GPM | Q-2 | 2.60 | 9.231 | | 8,525 | 252 | | 8,777 | 9,750 | |
| | 1220 | 8" mainline x 4" by-pass, 2800 GPM | | 2.10 | 11.429 | | 12,900 | 315 | | 13,215 | 14,700 | |
| | 1260 | 10" mainline x 6" by-pass, 4400 GPM | | 2 | 12 | | 21,000 | 330 | | 21,330 | 23,600 | |
| | 1300 | 10"x12" mainlines x 6" by-pass,5400 GPM | | 1.70 | 14.118 | | 21,900 | 385 | | 22,285 | 24,600 | |
| | 2000 | Domestic/commercial, bronze | | | | | | | | | | |
| | 2020 | Threaded | | | | | | | | | | |
| | 2060 | 5/8" diameter, to 20 GPM | 1 Plum | 16 | .500 | Ea. | 66.50 | 14.65 | | 81.15 | 96 | |
| | 2080 | 3/4" diameter, to 30 GPM | | 14 | .571 | | 115 | 16.75 | | 131.75 | 153 | |
| | 2100 | 1" diameter, to 50 GPM | | 12 | .667 | | 157 | 19.55 | | 176.55 | 202 | |
| | 2300 | Threaded/flanged | | | | | | | | | | |
| | 2340 | 1-1/2" diameter, to 100 GPM | 1 Plum | 8 | 1 | Ea. | 420 | 29.50 | | 449.50 | 505 | |
| | 2360 | 2" diameter, to 160 GPM | " | 6 | 1.333 | " | 615 | 39 | | 654 | 735 | |
| | 2600 | Flanged, compound | | | | | | | | | | |
| | 2640 | 3" diameter, 320 GPM | Q-1 | 3 | 5.333 | Ea. | 2,900 | 141 | | 3,041 | 3,425 | |
| | 2660 | 4" diameter, to 500 GPM | | 1.50 | 10.667 | | 4,525 | 281 | | 4,806 | 5,400 | |
| | 2680 | 6" diameter, to 1,000 GPM | | 1 | 16 | | 6,500 | 420 | | 6,920 | 7,825 | |
| | 2700 | 8" diameter, to 1,800 GPM | | .80 | 20 | | 12,800 | 530 | | 13,330 | 14,900 | |
| | 7000 | Turbine | | | | | | | | | | |
| | 7260 | Flanged | | | | | | | | | | |
| | 7300 | 2" diameter, to 160 GPM | 1 Plum | 7 | 1.143 | Ea. | 790 | 33.50 | | 823.50 | 920 | |
| | 7320 | 3" diameter, to 450 GPM | Q-1 | 3.60 | 4.444 | | 1,125 | 117 | | 1,242 | 1,425 | |
| | 7340 | 4" diameter, to 650 GPM | " | 2.50 | 6.400 | | 1,950 | 169 | | 2,119 | 2,400 | |
| | 7360 | 6" diameter, to 1800 GPM | Q-2 | 2.60 | 9.231 | | 3,250 | 252 | | 3,502 | 3,950 | |
| | 7380 | 8" diameter, to 2500 GPM | | 2.10 | 11.429 | | 6,925 | 315 | | 7,240 | 8,100 | |
| | 7400 | 10" diameter, to 5500 GPM | | 1.70 | 14.118 | | 9,475 | 385 | | 9,860 | 11,000 | |



# 155 | Heating

## 155 100 | Boilers

| | | | CREW | DAILY OUTPUT | MAN-HOURS | UNIT | 1995 BARE COSTS MAT. | LABOR | EQUIP. | TOTAL | TOTAL INCL O&P | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 101 | 0010 | AVERAGE Square foot and percent of total | | | | | | | | | | 101 |
| | 0020 | job cost, see division 171 | | | | | | | | | | |
| 105 | 0010 | BOILERS, GENERAL Prices do not include flue piping, elec. wiring, | | | | | | | | | | 105 |
| | 0020 | gas or oil piping, boiler base, pad, or tankless unless noted | | | | | | | | | | |



A-10-29

RS&H

SUBJECT FORT STEWART
CHILLED WATER SYSTEM
DESIGNER W.T.T.
CHECKER

AEP NO
SHEET 1 OF 3
DATE 8-16-95
DATE

## Chilled water makeup:

from operator logs for 7/94 - 6/95 the total amount of make up water for the chilled water distribution system = 1,106,710 gal/yr.

Averge make up ≈ 3000 gal/day

Average makeup = 2.1 gal/min

This amount should be approximately equal to the amount of leaks in the distribution system, and is much less than 1% of the total chilled water supplied to the distribution system.

## Energy Loss:

$$1106710 \frac{gal}{yr} \times \frac{8.345\ lb}{gal} \times 1 \frac{Btu}{lb\ °F} \times (70-49)°F = 193.9 \frac{MBtu}{YR}$$

Assuming all electric chillers (worst case):

$$193.9 \frac{MBtu}{YR} \times 0.70 \frac{kw}{ton} \times \frac{1\ ton}{12000\ Btu} = 11,310\ kwh/YR$$

$$Cost = 11,310\ kwh/yr \times \$0.0500/kwh = \$566/YR$$

## Pumping Cost:

$$Pump\ BHP = \frac{GPM \times Head}{3960 \times eff} = \frac{2.1 \times 250^{*}}{3960 \times 0.72} = 0.18\ BHP$$

$$0.18\ BHP \times 0.746 \frac{KW}{HP} \div 0.9\ motor\ eff. \times 8760\ hr/yr = 1310\ kwh/yr$$

A.10-30 * from record drawings

RS&H

SUBJECT FORT STEWART CHILLED WATER SYSTEM
DESIGNER WTT
CHECKER

AEP NO

DATE
DATE

Pumping Cost = 1310 kWh/yr × $0.0500/kWh = $66/YR

Water Cost:

$$1,106,710 \frac{\text{gal}}{\text{yr}} \times \frac{\$0.5562}{1000 \text{ gal}} = \$615/\text{YR}$$

Total Cost

Energy Cost + Pumping Cost + Water Cost = Total

Total Cost = $566 + $66 + $615 = $1247/YR

Percent Losses

$$\frac{3023 \frac{\text{Gal}}{\text{day}} \text{ Makeup}}{601184 \text{ Gal. Volume}} \times 100 = 0.5\%$$

RS&H

SUBJECT FORT STEWART
CHILLED WATER SYSTEM
DESIGNER WTT
CHECKER

AEP NO
SHEET 3 OF 3
DATE 8-16-95
DATE

Energy Required to Produce Chilled Water:

- Chiller : Assume 1994-95 model centrifugal chiller.

  Energy demand = 0.60 kw/ton

- Condenser Pumps :

  Assume: 3 gpm/ton (standard)
  Pump head = 60 ft, eff. = 0.72

$$\frac{3 \frac{gpm}{ton} \times 60 \text{ ft}}{3960 \times 0.72} = 0.06 \text{ BHP/ton}$$

$$0.06 \frac{BHP}{ton} \times 0.746 \frac{KW}{BHP} \div 0.9 \ \substack{\text{motor} \\ \text{eff.}} = 0.05 \text{ KW/ton}$$

- Cooling Tower Fans :

  Assume : 100 hp for 1500 ton chiller (BAC catalog)
  85% motor loading, 90% motor eff.

$$\frac{100 \text{ hp} \times 0.85}{1500 \text{ tons}} \times 0.746 \frac{KW}{BHP} \div 0.9 = 0.05 \text{ KW/ton}$$

- Total Energy Demand = 0.60 + 0.05 + 0.05 = 0.70 KW/ton

Fort Stewart Central Energy Plant
Chiller Makeup Water
Filename: FS-CHW.WQ1

| Month | Year | Chiller Makeup Gal (1) | Days/ Month | Makeup Gal/Day | Chiller Makeup Gal/Min |
|---|---|---|---|---|---|
| 7 | 94 | 210400 | 31 | 6787 | 4.7 |
| 8 | 94 | 131600 | 31 | 4245 | 2.9 |
| 9 | 94 | 83830 | 30 | 2794 | 1.9 |
| 10 | 94 | 76360 | 31 | 2463 | 1.7 |
| 11 | 94 | 290300 | 30 | 9677 | 6.7 |
| 12 | 94 | 58000 | 31 | 1871 | 1.3 |
| 1 | 95 | 18470 | 31 | 596 | 0.4 |
| 2 | 95 | 10310 | 28 | 368 | 0.3 |
| 3 | 95 | 25500 | 31 | 823 | 0.6 |
| 4 | 95 | 90810 | 30 | 3027 | 2.1 |
| 5 | 95 | 69570 | 31 | 2244 | 1.6 |
| 6 | 95 | 41560 | 30 | 1385 | 1.0 |
| AVERAGES | | 92226 | | 3023 | 2.1 |

TOTAL 1106710 gal/yr

(1) Source is Fort Stewart Operating Logs.

Estimate of Distribution System Losses:

2.1 gpm, avg make-up water

Fort Stewart - Central Energy Plant
Estimate of CHW System Losses
Filename: F-CHW-CP.WQ1

| Pipe Service | Bldg. Served | Pipe Dia. (in) | Linear Feet | Pipe Vol. (CF) | Pipe Vol. (Gal) |
|---|---|---|---|---|---|
| ZONE 1 | | | | | |
| CWS | All (main) | 18 | 1350 | 2385.6 | 17847 |
| CWR | All (main) | 18 | 1350 | 2385.6 | 17847 |
| CWS | All (main) | 16 | 2000 | 2792.5 | 20891 |
| CWR | All (main) | 16 | 2000 | 2792.5 | 20891 |
| CWS | All (main) | 14 | 200 | 213.8 | 1599 |
| CWR | All (main) | 14 | 200 | 213.8 | 1599 |
| CWS | All (main) | 12 | 1850 | 1453.0 | 10870 |
| CWR | All (main) | 12 | 1850 | 1453.0 | 10870 |
| CWS | All (main) | 10 | 750 | 409.1 | 3060 |
| CWR | All (main) | 10 | 750 | 409.1 | 3060 |
| CWS | All (main) | 8 | 750 | 261.8 | 1959 |
| CWR | All (main) | 8 | 750 | 261.8 | 1959 |
| CWS | All (main) | 5 | 800 | 109.1 | 816 |
| CWR | All (main) | 5 | 800 | 109.1 | 816 |
| CWS | All (main) | 10 | 350 | 190.9 | 1428 |
| CWR | All (main) | 10 | 350 | 190.9 | 1428 |
| CWS | All (main) | 8 | 800 | 279.3 | 2089 |
| CWR | All (main) | 8 | 800 | 279.3 | 2089 |
| CWS | All (main) | 6 | 400 | 78.5 | 588 |
| CWR | All (main) | 6 | 400 | 78.5 | 588 |
| Branch Piping (assume 5% of mains) | | | | | 6115 |
| 60 Buildings Piping (estimate) | | | | | 12000 |
| SUBTOTAL ZONE 1 | | | 16100 | | 140409 |
| | | | | | |
| ZONE 2 | | | | | |
| CWS | All (main) | 14 | 3700 | 3955.4 | 29590 |
| CWR | All (main) | 14 | 3700 | 3955.4 | 29590 |
| CWS | All (main) | 10 | 1250 | 681.8 | 5100 |
| CWR | All (main) | 10 | 1250 | 681.8 | 5100 |
| CWS | All (main) | 8 | 500 | 174.5 | 1306 |
| CWR | All (main) | 8 | 500 | 174.5 | 1306 |
| Branch Piping (assume 5% of mains) | | | | | 3600 |
| 22 Buildings Piping (estimate) | | | | | 4400 |
| SUBTOTAL ZONE 2 | | | | | 79992 |

ZONE 3

| | | | | | |
|---|---|---|---|---|---|
| CWS | All (main) | 24 | 4750 | 14922.6 | 111638 |
| CWR | All (main) | 24 | 4750 | 14922.6 | 111638 |
| CWS | All (main) | 18 | 3500 | 6185.0 | 46271 |
| CWR | All (main) | 18 | 3500 | 6185.0 | 46271 |
| CWS | All (main) | 12 | 900 | 706.9 | 5288 |
| CWR | All (main) | 12 | 900 | 706.9 | 5288 |
| CWS | All (main) | 16 | 550 | 767.9 | 5745 |
| CWR | All (main) | 16 | 550 | 767.9 | 5745 |
| CWS | All (main) | 14 | 550 | 588.0 | 4399 |
| CWR | All (main) | 14 | 550 | 588.0 | 4399 |
| CWS | All (main) | 10 | 1000 | 545.4 | 4080 |
| CWR | All (main) | 10 | 1000 | 545.4 | 4080 |
| Branch Piping (assume 5% of mains) | | | | | 17742 |
| 16 Buildings Piping (estimate) | | | | | 3200 |
| SUBTOTAL ZONE 3 | | | 22500 | | 375784 |

Plant, Expansion Tanks, etc 5000

Total Estimated System Volume 601184 Gallons

1.0% of total volume lost per day = 6012 Gal/Day

6012 gal/day x 30 day/mo = 180355 Gal/Mo.

6012 gpd / 1440 min/day = 4.17 Gal/Min

100.0% of total volume lost per day = 601184 Gal/Day

601184 gal/day x 30 day/mo = 18035532 Gal/Mo.

601184 gpd / 1440 min/day = 417 Gal/Min

Repair History & Cost for the CHW Distribution System
Fort Stewart, GA
Filename: FSREPAIR.WQ1

| Chilled Water System | | |
|---|---|---|
| Date | Labor Hrs | Cost |
| 10-17-94 | 3.4 | $92 |
| 10-19-94 | 11.0 | $304 |
| 10-19-94 | 5.0 | $135 |
| 12-09-94 | 2.9 | $79 |
| 12-09-94 | 2.8 | $76 |
| 3 MONTH | 25.1 | $686 |
| | x 4 | x 4 |
| | ------ | ------ |
| TOTALS | 100.4 | $2,742 |

**RS&H**

| | | | |
|---|---|---|---|
| SUBJECT | FORT STEWART | AEP NO | |
| | HTW DIST. SYSTEM | SHEET | 1 OF |
| DESIGNER | WTT | DATE | 8-17-95 |
| CHECKER | | DATE | |

## Estimate of HTW System Losses

The metered flow of makeup water for the HTW system was obtained from operating logs for 7/94 through 6/95. Flows for the three chemical treatment system were estimated based on conversations with CEP personnel. The total makeup water less the estimated boiler blowdown is the total system losses.

HTW System Losses = 15917 gal/day

$15917 \times 365 = 5{,}809{,}705$ gal/year

$15917 \div 24 \div 60 = 11$ gal/min

## Energy Losses

$$5809705 \frac{\text{gal}}{\text{yr}} \times 8.345 \frac{\text{lb}}{\text{gal}} \times 1 \frac{\text{Btu}}{\text{lb}\,{}^\circ\text{F}} \times (380-70)\,{}^\circ\text{F} = 15029 \frac{\text{mBtu}}{\text{YR}}$$

$$\text{Fuel use} = 15029 \frac{\text{mBtu}}{\text{yr}} \div 0.68 \text{ boiler eff.} = \underline{22{,}100 \frac{\text{mBtu}}{\text{YR}}}$$

$$\text{Fuel cost} = 22{,}100 \frac{\text{mBtu}}{\text{YR}} \times \$1.16/\text{mBtu} = \underline{\$25{,}640/\text{YR}}$$

## Pumping Cost

$$\text{Pump BHP} = \frac{\text{GPM} \times \text{Head}}{3960 \times \text{eff}} = \frac{11 \times 300^*}{3960 \times 0.72^*} = 1.16 \text{ BHP}$$

* Data from record drawings

Pumping cost - continued.

$1.16 \text{ BHP} \times 0.746 \frac{\text{KW}}{\text{HP}} \div 0.90 \text{ motor eff} \times 8760 \frac{\text{hr}}{\text{YR}} = \underline{8404 \frac{\text{kwh}}{\text{YR}}}$

Cost = $8400 \text{ kwh/yr} \times \$0.0500/\text{kwh} = \underline{\$420/\text{YR}}$

## Water Cost

$5809705 \frac{\text{gal}}{\text{YR}} \times \frac{\$0.5562}{1000 \text{ gal}} = \underline{\$3{,}230/\text{year}}$

## Total Cost

Total = Energy Cost + Pumping Cost + Water Cost

Total Cost = $25,640 + $420 + $3,230 = **$29,290/YR**

Fort Stewart Central Energy Plant
Boiler Makeup Water
Filename: FS-HTW1.WQ1

| Month | Year | WS Makeup Gal(1) | Days/ Month | Makeup Gal/Day | S Makeup Gal/Day | M Makeup Gal/Day | P Makeup Gal/Day | Total Makeup Gal/Day |
|---|---|---|---|---|---|---|---|---|
| 7 | 94 | 535250 | 31 | 17266 | 72 | 72 | 7200 | 24610 |
| 8 | 94 | 407100 | 31 | 13132 | 72 | 72 | 7200 | 20476 |
| 9 | 94 | 246220 | 30 | 8207 | 72 | 72 | 7200 | 15551 |
| 10 | 94 | 136384 | 31 | 4399 | 72 | 72 | 7200 | 11743 |
| 11 | 94 | 442980 | 30 | 14766 | 72 | 72 | 7200 | 22110 |
| 12 | 94 | 419160 | 31 | 13521 | 72 | 72 | 7200 | 20865 |
| 1 | 95 | 403424 | 31 | 13014 | 72 | 72 | 7200 | 20358 |
| 2 | 95 | 383366 | 28 | 13692 | 72 | 72 | 7200 | 21036 |
| 3 | 95 | 360940 | 31 | 11643 | 72 | 72 | 7200 | 18987 |
| 4 | 95 | 264078 | 30 | 8803 | 72 | 72 | 7200 | 16147 |
| 5 | 95 | 206480 | 31 | 6661 | 72 | 72 | 7200 | 14005 |
| 6 | 95 | 224254 | 30 | 7475 | 72 | 72 | 7200 | 14819 |
| AVERAGES | | 335803 | | 11048 | 72 | 72 | 7200 | 18392 |
| TOTALS | | 4029636 | gal/yr | | | | | |

(1) Source is Fort Stewart Boiler Operating Logs.
WS - Water softener makup water from meter readings.
S - Sulfite (oxygen control) chemical feed makeup water estimate.
M - Morpholine (PH control) chemical feed makeup water estimate.
P - Phophate (calcium control) chemical feed makeup water estimate.

Estimate Distribution System Losses:

| | | |
|---|---|---|
| | 18392 | gpd, avg make-up water |
| - | 2475 | gpd, avg blowdown water * |
| | 15917 | gpd, avg dist system losses |

* Boiler blowdown estimate:

| | | |
|---|---|---|
| | 165 | gpm |
| x | 5 | min/shift |
| | 825 | gal/shift |
| x | 3 | shift/day |
| | 2475 | gal/day |

Fort Stewart Central Energy Plant
Energy Consumption
Filename: FS-ENRGY.WQ1

| Month | Yr | Wood Tons (1) | Wood MBtu (2) | Wood Cost (2) | #2 Oil Gals (1) | #2 Oil MBtu (3) | #2 Oil Cost (3) | Used Oil Gals (4) | Used Oil MBtu (5) | Used Oil Cost (5) | N.Gas CuFt (1) | N.Gas MBtu (6) | N.Gas Cost (6) | Total MBtu | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | 94 | 6052 | 74137 | 65483 | 75497 | 10645 | 46808 | 0 | 0 | 0 | 5572730 | 5701 | 18563 | 90483 | 130854 |
| 8 | 94 | 8169 | 100070 | 88389 | 13822 | 1949 | 8570 | 12956 | 1749 | 0 | 874295 | 894 | 2878 | 104662 | 99836 |
| 9 | 94 | 4969 | 60870 | 53765 | 40667 | 5734 | 25214 | 17703 | 2390 | 0 | 352500 | 361 | 1056 | 69355 | 80034 |
| 10 | 94 | 3947 | 48351 | 42707 | 42608 | 6008 | 26417 | 18775 | 2535 | 0 | 598230 | 611 | 1790 | 57504 | 70913 |
| 11 | 94 | 5000 | 61250 | 54100 | 15884 | 2240 | 9848 | 24298 | 3280 | 0 | 1082030 | 1107 | 3488 | 67877 | 67436 |
| 12 | 94 | 6631 | 81232 | 71749 | 22257 | 3138 | 13799 | 9470 | 1278 | 0 | 1366090 | 1398 | 4363 | 87046 | 89912 |
| 1 | 95 | 6100 | 74726 | 66003 | 39741 | 5603 | 24639 | 8891 | 1200 | 0 | 1027820 | 1049 | 3199 | 82579 | 93841 |
| 2 | 95 | 5024 | 61544 | 54360 | 110411 | 15568 | 68455 | 13181 | 1779 | 0 | 1159730 | 1186 | 3368 | 80078 | 126182 |
| 3 | 95 | 5723 | 70107 | 61923 | 19404 | 2736 | 12030 | 11576 | 1563 | 0 | 518890 | 530 | 1463 | 74935 | 75417 |
| 4 | 95 | 1869 | 22895 | 20223 | 550 | 78 | 341 | 0 | 0 | 0 | 12995190 | 13268 | 37455 | 36241 | 58019 |
| 5 | 95 | 5322 | 65195 | 57584 | 6525 | 920 | 4046 | 11324 | 1529 | 0 | 550120 | 563 | 1724 | 68207 | 63354 |
| 6 | 95 | 4768 | 58408 | 51590 | 11466 | 1617 | 7109 | 5476 | 739 | 0 | 2081740 | 2128 | 6435 | 62892 | 65134 |
| AVERAGES | | 5298 | 64899 | 57323 | 33236 | 4686 | 20606 | 11138 | 1504 | 0 | 2348280 | 2400 | 7148 | 73488 | 85078 |
| TOTALS | | 63574 | 778785 | 687874 | 398832 | 56235 | 247276 | 133650 | 18043 | 0 | 28179365 | 28796 | 85782 | 881859 | 1020931 |
| AVG COST | | | $0.88 /MBtu | | | $4.40 /MBtu | | | $0.00 /MBtu | | | $2.98 /MBtu | | $1.16 /MBtu | |

(1) Source is Fort Stewart Operating Logs.
(2) Assumes heating value of 6125 btu/lb; cost is $10.82/ton.
(3) Assumes heating value of 141000 btu/gal; cost is $0.62/gal.
(4) Source is monthly Oil Reports prepared at the CEP.
(5) Assumes heating value of 18000 btu/lb, 7.5 lb/gal; no cost.
(6) Uses heating value and cost from utility bills.

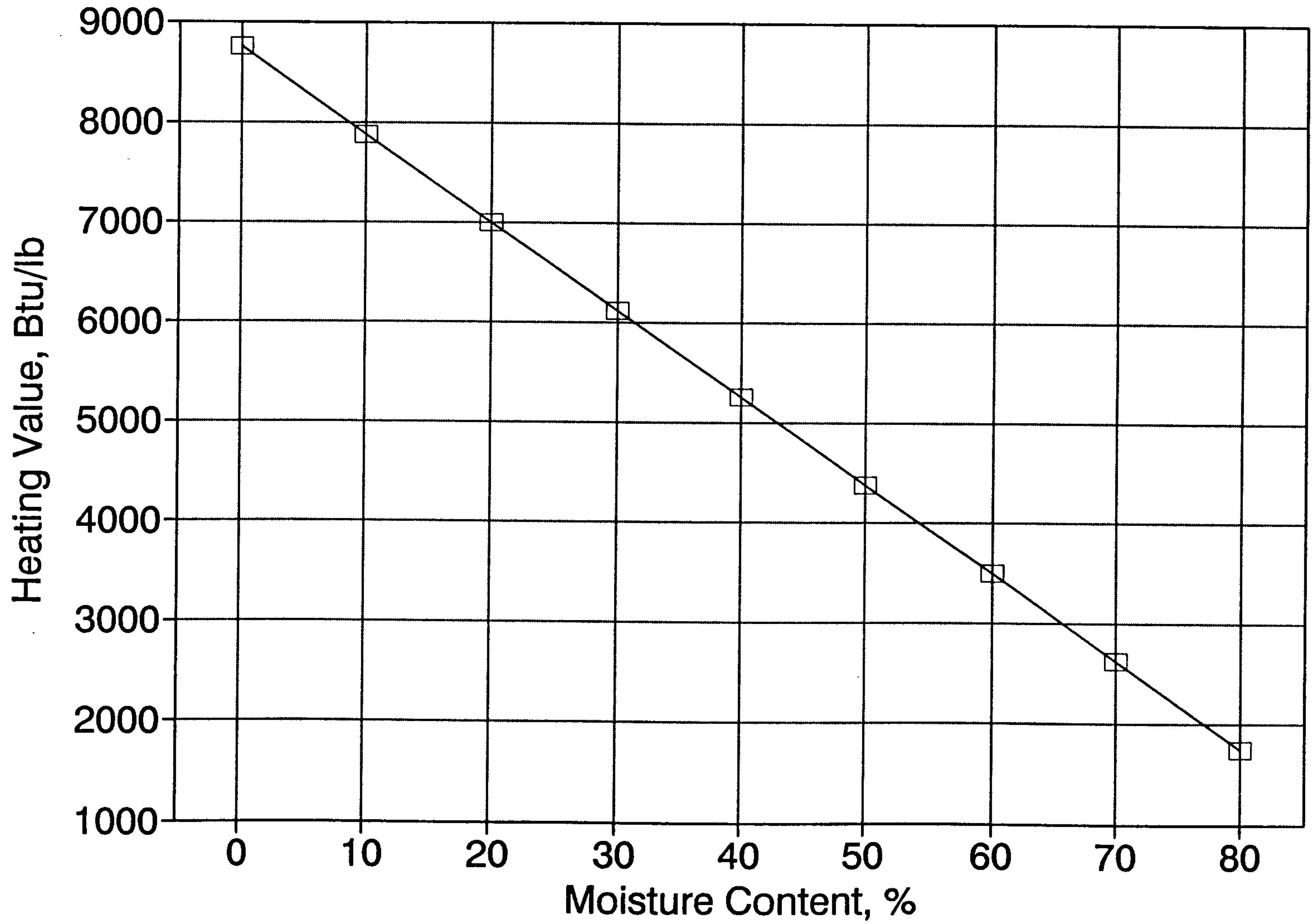
Fort Stewart Central Energy Plant
Energy Production
Filename: FS-ENRGY.WQ1

| Month | Yr | Steam Prod k lb (1) | Steam Prod MBtu (2) | Fuel Input MBtu | Avg Eff (3) |
|---|---|---|---|---|---|
| 7 | 94 | 60989 | 73187 | 90483 | 81% |
| 8 | 94 | 62837 | 75404 | 104662 | 72% |
| 9 | 94 | 44574 | 53489 | 69355 | 77% |
| 10 | 94 | 43662 | 52394 | 57504 | 91% |
| 11 | 94 | 38255 | 45906 | 67877 | 68% |
| 12 | 94 | 49619 | 59543 | 87046 | 68% |
| 1 | 95 | 55003 | 66004 | 82579 | 80% |
| 2 | 95 | 50776 | 60931 | 80078 | 76% |
| 3 | 95 | 45611 | 54733 | 74935 | 73% |
| 4 | 95 | 34688 | 41626 | 36241 | 115% |
| 5 | 95 | 37774 | 45329 | 68207 | 66% |
| 6 | 95 | 40653 | 48784 | 62892 | 78% |
| AVERAGE | | 47037 | 56444 | 73488 | 79% |
| TOTALS | | 564441 | 677329 | 881859 | |

(1) Source is Fort Stewart Operating Logs.
(2) Total heat content of steam @ 200 psi is 1200 Btu/lb.
(3) Calculated based on input and output data provided.

# Available Energy In Wood

Source: Marks Mech Eng Hndbk, Pg 7-11



Heating Value of Wood Fuel
Filename: WOOD-HV.WQ1

| Moisture Content, % | Heating Value, Btu/lb | |
|---|---|---|
| 0 | 8750 | |
| 10 | 7875 | * |
| 20 | 7000 | |
| 30 | 6125 | * |
| 40 | 5250 | * |
| 50 | 4375 | |
| 60 | 3500 | * |
| 70 | 2625 | * |
| 80 | 1750 | |

Source: Marks' Handbook for Mechanical Engineers
* These values were extrapoleted.

Repair History & Cost for the HTW Distribution System
Fort Stewart, GA
Filename: FSREPAIR.WQ1

| High Temperature System | | |
|---|---|---|
| Date | Labor Hrs | Cost |
| 04-08-94 | 5.0 | $125 |
| 04-11-94 | 4.0 | $100 |
| 04-11-94 | 14.0 | $321 |
| 04-11-94 | 3.6 | $90 |
| 04-13-94 | 4.6 | $135 |
| 10-27-94 | 14.2 | $501 |
| 11-04-94 | 1.9 | $51 |
| 11-17-94 | 6.0 | $2,703 |
| 03-01-95 | 7.0 | $175 |
| TOTALS | 60.3 | $4,202 |

**RS&H**

# Telephone Call Confirmation

912-767-8931

Project Number 694 1331 002

Local ______ L.D. ______ Placed ______ Rec'd ______ Date 8-14-95

Conversed with Randy Parks of Ft. Stewart CEP

Regarding HTW Makeup water & chemical treatment at CEP

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The mixing tank for feedwater to the wood-fired boiler is used to add Morpholine and phosphate on a continuous basis.

The chemical feed systems for the other boilers are used to add sulphite and morpholine. They estimate the flow from these systems to be about 3 gal/hr each.

The existing makeup water meter does not include any of these chemical feed systems.

The HTW is tested for sulphite and PH. They try to keep the ph between 8.3 and 8.5 (9.3-9.9 is recommended). They try to keep the sulfite between 30 and 40 ppm.

Distribution:

# Gas and Liquid Leak Detector

The XLT-16 is revolutionary in that it has both a sonic range to sense liquid leaks and an ultrasonic range to sense gaseous leaks. Both systems are within a very compact control box. Water companies and liquid leak detection professionals can make use of the ultrasonic range when they add air to a water system to cause a distinct "sputtering" at the leak location. Additional uses for the ultrasonic range are: to sense bearing wear, valve flow and seatings, corona discharge, leaking steam traps, and general mechanical trouble shooting. Do not use for detecting leaks of flameable gases.

NEW PRODUCT

### Features

- Compact control box which can be worn: on the belt; around the neck or over the shoulder with the attachable strap.
- Both sonic and ultrasonic frequency ranges can be sensed for leaks.
- Minimum number of controls for a user-friendly control panel.
- Listening is loudness limited to lessen sudden blasts of uncomfortable sound.
- The "Big Foot" and Hydrophonic Cylinder Probes have three position switches for: (1) mute, (2) momentary on, or (3) locked on.
- The "Big Foot" probe is compact for access in tight areas.
- The carrying case holds all items of the basic set plus the two accessory transducers and a set of spare batteries (not included).

### SPECIFICATIONS

| | | | |
|---|---|---|---|
| **Frequency:** | | **Batteries:** | 2 ea. 9 volt (NEDA 1604) |
| **Sonic Range:** | Tuneable 100 Hz - 5 KHz<br>Flat Band 100 Hz - 15 KHz | **Battery Life:** | 20 hours - intermittent use with standard carbon zinc batteries |
| **Ultrasonic Range:** | 38 KHz - 42 KHz | **Headset Impedance:** | 150 ohms |
| **Listening Frequency for Both Ranges:** | Tuneable 100 Hz - 5 KHz<br>Flat Band 100 Hz - 15 KHz | **Weight:** | (In carrying case with both accessory transducers) |
| **Gain:** | 85 dB | **Size:** | (Carrying case) |
| **Type of Filters:** | Tuneable and Flat Band | | 7-1/4 x 19 x 15 inches (18.4 x 48.2 x 38.1 cm.) |

**Each Kit Includes:**
Complete with carrying case, cushioned headphones, "Big Foot" probe, hydrophonic cylinder probe, three 16" sound rods, four inch sound rod, T-handle, coil cord, cassette recorded training tape, instruction book.


### ORDERING INFORMATION

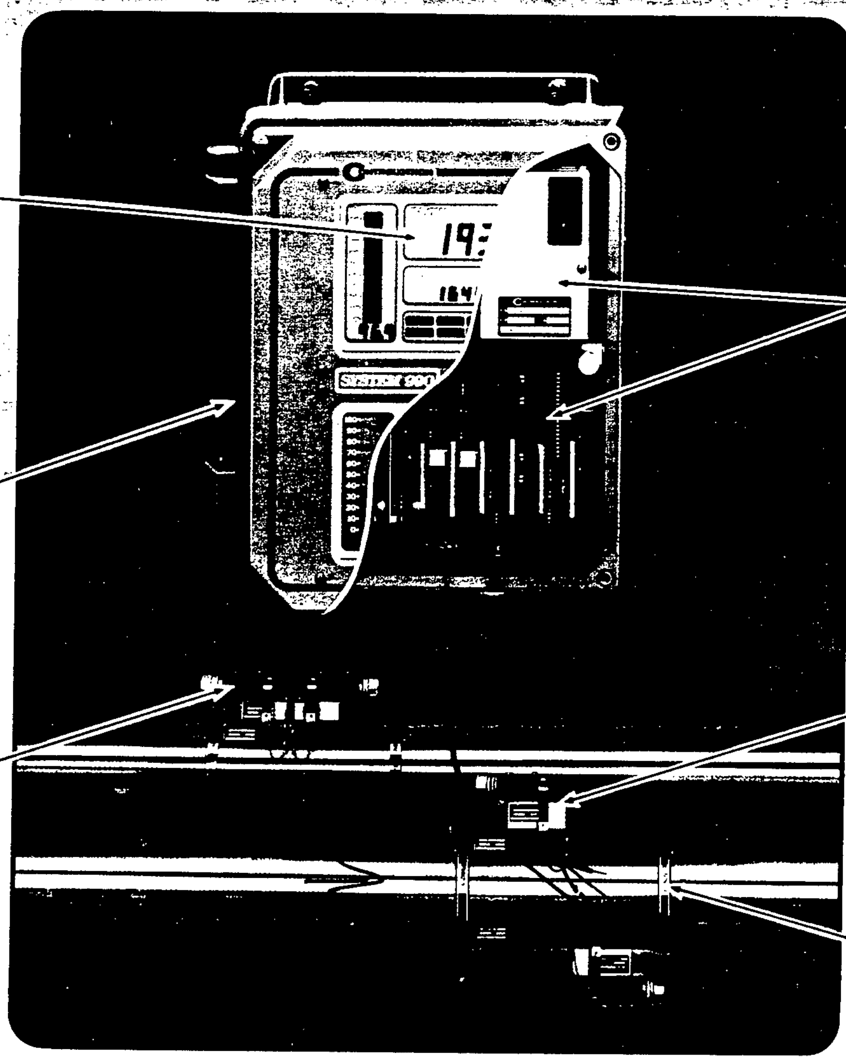
| Catalog No. | Model | Description | Price |
|---|---|---|---|
| FI096510 | XLT-16 | Leak Detector Kit | $1125.00 |
| FI096511 | 202352 | Ultrasonic Probe | $ 95.00 |
| FI096512 | 202357 | Little Foot Probe | $ 225.00 |
| FI096513 | 202374 | 25' Extension Cable For Ultrasonic Probe | $ 35.00 |

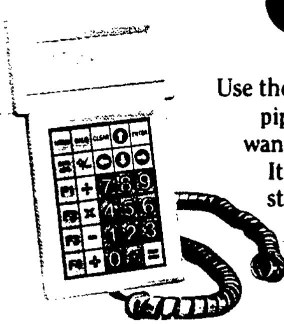
[redacted]

# DEDICATED UNIFLOW

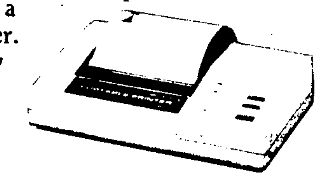
## Better Performance, Reliability and Economy than Magmeters, Vortex, Venturis, Turbines and Orifice Plates in Most Applications.

### System 990N Uniflow Dedicated NEMA 4X Field Programmable Flow Computer



Use the 995T Hand-Held CDU to tell Uniflow the pipe size you want to work on, and what you want it to measure, display, record or control. It takes only minutes to setup a site and install transducers, and only seconds to recall a previously saved site. Used only for Site Setup and Installation, only one 995T Hand-Held CDU is needed to service many individual 990N NEMA 4 Systems.



The 996P Portable Thermal Printer features quiet, high-contrast printing. An RS-232C serial connector is provided for interconnection to a Flow Display Computer. A rechargeable battery allows printing up to 1,500 character lines, before re-charging. This printer is provided in a convenient soft carry case.

# A New Standard in Flowmeter Accuracy and Rangeability... Made Possible by UNIFLOW's MultiPulse™ and TransX™ Technology.

## HOW UNIFLOW WORKS

Uniflow is a Clamp-On Flowmeter which detects liquid flow rate by its effect on the Transit-Time of Ultrasonic Pulses, alternatively injected through the pipe wall in the upstream and downstream directions by Controlotron's patented ultrastable metallic transducers. Each transmission is not a single pulse, as in prior types of ultrasonic flowmeters, but rather as many as 100 pulses, resulting in the extraordinary sensitivity and calibration stability of Uniflow's MultiPulse™ System.

Uniflow also benefits from its patented TransX™ Transmission System. This is a method by which Uniflow measures the sonic properties of the application's pipe, and automatically optimizes its ultrasonic beam transmission. This gives Uniflow its Universality, the ability to operate on most pipes and most liquids, and its extraordinary immunity to such conditions as liquid aeration and non-homogeneity.

## HOW DOES UNIFLOW PERFORM?

### EXTRAORDINARY PERFORMANCE

Uniflow's Digital MultiPulse™ System uses no analog circuits, not even phase locked loops. This produces the greatest precision, sensitivity and stability ever achieved in an ultrasonic flowmeter. Flow response is extremely linear over its full ±40 fps range (including zero flow), and is virtually drift free.

Uniflow's SMARTSLEW™ real time data analysis results in extremely low data scatter, even at high slew rate settings. When set for its fastest flow response rate, Uniflow is ideal for flow control or detection of flow transients which would be missed by slower flowmeters. Slower response can be selected, if desired, to avoid reporting flow pulsations which are not of interest.

Uniflow intrinsic calibration accuracy is usually within 1% to 2% in most applications and within 1/4% to 1% if flow calibrated.* Intrinsic repeatability will generally be within 1/2% for most pipe sizes.

## SYSTEM 990 UNIFLOW SPECIFICATIONS

**APPLICABILITY**

**LIQUIDS:** Any sonically conductive homogeneous liquid of low to moderate aeration (up to 30% maximum).

**LIQUID (PIPE) TEMPERATURE:** −40°F to +250°F (−40°C to +120° C) Standard
−80°F to +450°F (−60°C to +230° C) Optional

**PIPE SIZES:** 0.25" to 8" OD (6.35mm to 203.2mm) Specify Group 2 Flow Computer
0.5" to 24" OD (12.7mm to 609.6mm) Specify Group 3 Flow Computer
0.5" to 48" OD (12.7mm to 1219.2mm) Specify Group 4 Flow Computer
0.5" to 216" OD (12.7mm to 5486.4mm) Specify Group 5 Flow Computer
0.5" to 360" OD (12.7mm to 9144mm) Specify Group 6 Flow Computer

**PIPE MATERIAL:** Any sonically conductive pipe material: Metal, Glass, Plastic, etc.

**PIPE WALL THICKNESS:** 0.01" to 3.00" (0.25mm to 76.2mm)

**LINER MATERIAL:** Any sonically conductive material, Glass, Plastic, Cement, etc., intimately bonded to the pipe interior.

**LINER THICKNESS:** Up to 1" (25.4mm), dependent on material.

**FLOW VELOCITY RANGE:** ±40 fps (±12.2m/sec), minimum

**991 CLAMP-ON TRANSDUCERS**

**PIPE SIZE RATINGS:**
- Group 0: 0.25" to 2" (6.35mm to 50.8mm) pipe OD
- Group 1: 0.5" to 4" (12.7mm to 101.6mm) pipe OD
- Group 2: 1.25" to 8" (31.75mm to 203.2mm) pipe OD
- Group 3: 6" to 24" (152.4mm to 609.6mm) pipe OD
- Group 4: 20" to 48" (508.0mm to 1219.2mm) pipe OD
- Group 5: 36" to 360" (914.4mm to 9144.0mm) pipe OD

**RATING:** Intrinsically safe. Radiation Resistant and Submersible available.

**CONSTRUCTION:** Aluminum, stainless steel and special alloy or plastic.

**CONNECTORS:** Condulet for NEMA 4, BNC for Portable.

**992 MOUNTING TRACKS**
- Available in Direct and Reflect Mounting for all transducer sizes in standard pipe diameter ranges.
- PinStop transducer spacing standard for all models.

**994 FLOW COMPUTER**
- **POWER:** 100/120 or 220/240 VAC, 1$\phi$, 40 VA
  9 to 36 VDC, 20W, portable systems available with internal battery
- **TEMPERATURE:** −5°F to +115°F (−20°C to +45°C) (except for Graphics Models)
- **SIZE:** 10.5" W, 9" D, 13" H (266.7mm W, 228.6mm D, 330.2mm H)
- **WEIGHT:** 12.8 pounds (5.8 kilograms), (without Battery)
- **RATING:** Intrinsically safe. NEMA 4X with cover closed.
- **MODULES:** Plug-In, Interchangeable W/O special tools
- **RANGES:** Group 2: Transducer Sizes 0, 1 and 2
  Group 3: Transducer Sizes 1, 2 and 3
  Group 4: Transducer Sizes 1, 2, 3 and 4
  Groups 5 & 6: Transducer Sizes 1, 2, 3, 4 and 5

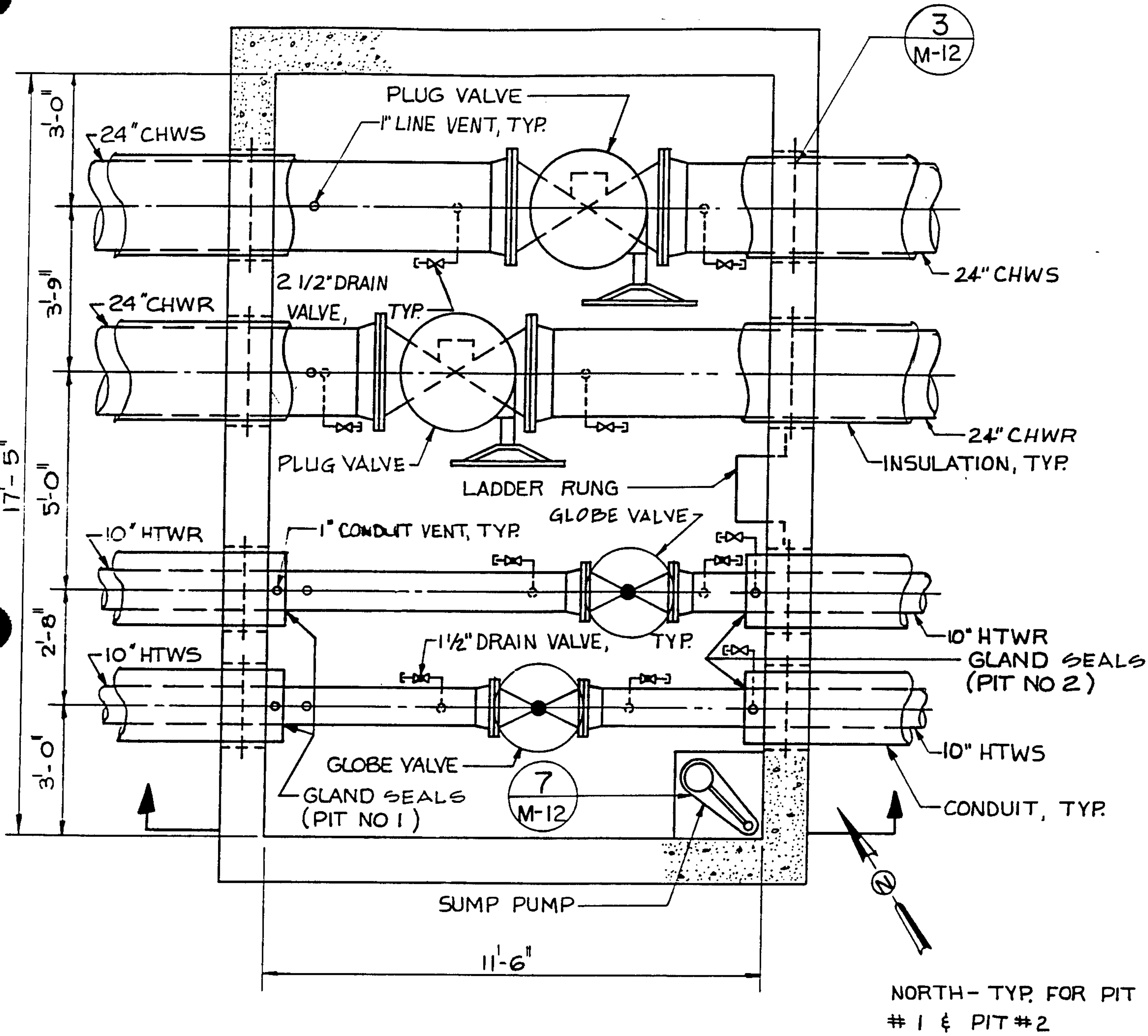
**994 PERFORMANCE (Standard Conditions)***
- **SENSITIVITY:** 0.001 fps (0.3mm/sec) at any flow rate including zero.
- **LINEARITY:** 0.003 fps (0.9mm/sec) under standard conditions.
- **DATA UPDATE RATE:** 10 Hz
- **SLEW RATE:** 0.1 to 40 ft/sec/sec (0.03 to 12.2m/sec/sec), (settable)
- **FLOW PROFILE COMPENSATION:** Reynold's Number 0 to $10^7$
- **ZERO DRIFT STABILITY:** 0.02 fps (6mm/sec) for transducer sizes 0 to 2
  0.01 fps (3mm/sec) for transducer sizes 3 to 5

**995 HAND HELD CONTROL/DISPLAY TERMINAL**
- 4 row, 80 character LCD
- 30 Keys, Numeric or Function identified

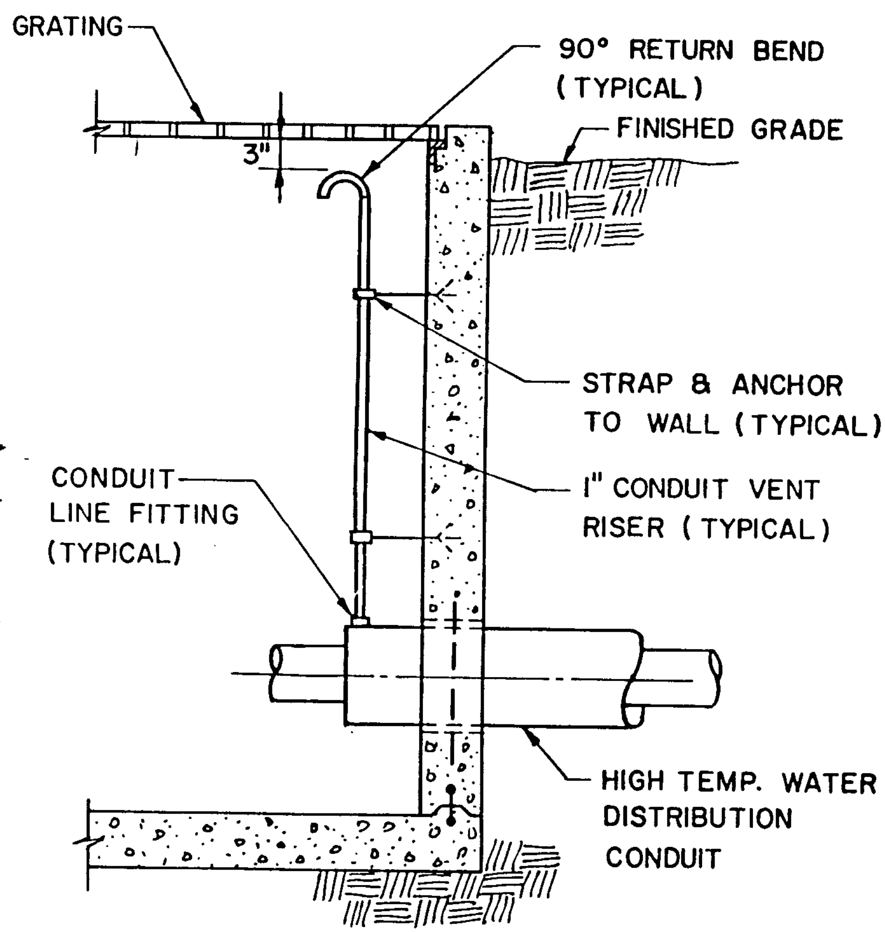
* **Submit Application Form for estimate of performance under specific application conditions. For statement of accuracy, site survey is required.**



A.10-48

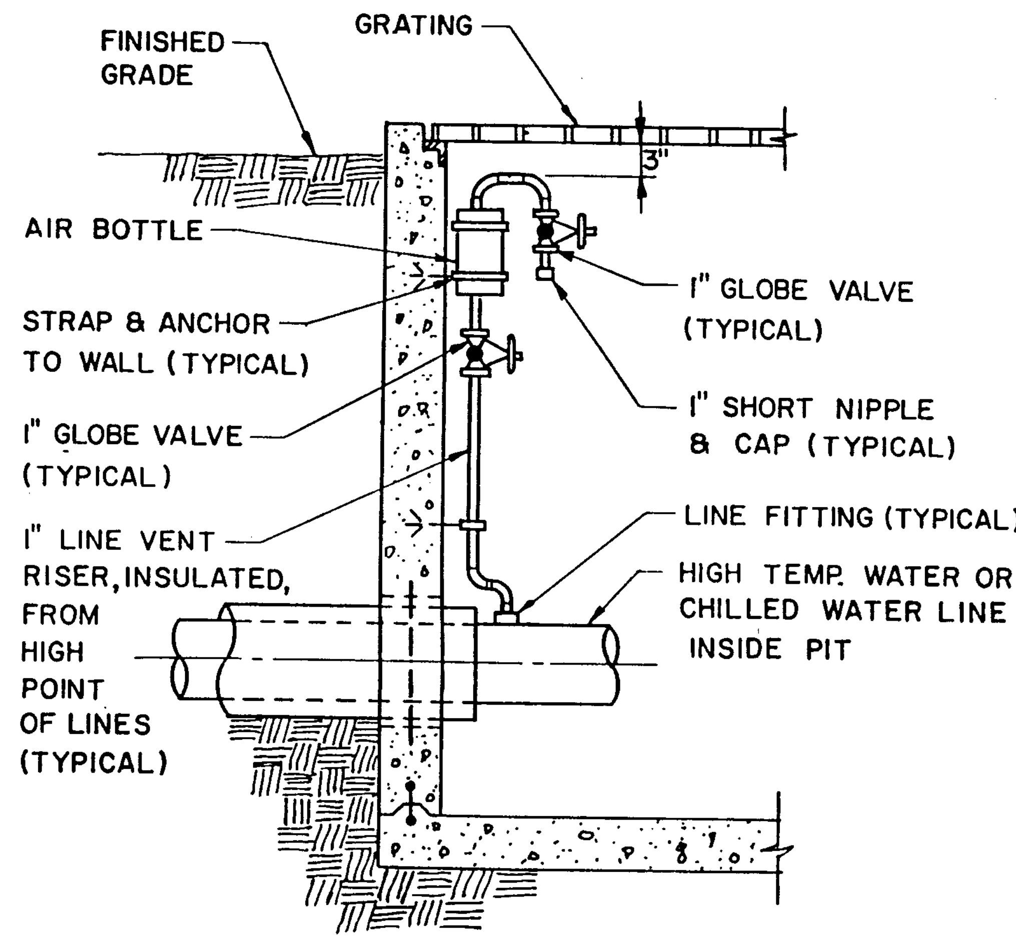

3
M-12
PLUG VALVE
1" LINE VENT, TYP.
24"CHWS
24" CHWS
2 1/2" DRAIN
VALVE, TYP.
24"CHWR
24" CHWR
PLUG VALVE
INSULATION, TYP.
LADDER RUNG
GLOBE VALVE
1" CONDUIT VENT, TYP.
10" HTWR
10" HTWR
1½" DRAIN VALVE, TYP.
GLAND SEALS
(PIT NO 2)
10" HTWS
10" HTWS
GLOBE VALVE
GLAND SEALS
(PIT NO 1)
7
M-12
CONDUIT, TYP.
SUMP PUMP
11'-6"
3'-0"
3'-9"
5'-0"
2'-8"
3'-0"
17'-5"
N
NORTH - TYP. FOR PIT
#1 & PIT #2

VALVE PIT




5 / M-12 TYPICAL CONDUIT VENT DETAILS

NOT TO SCALE

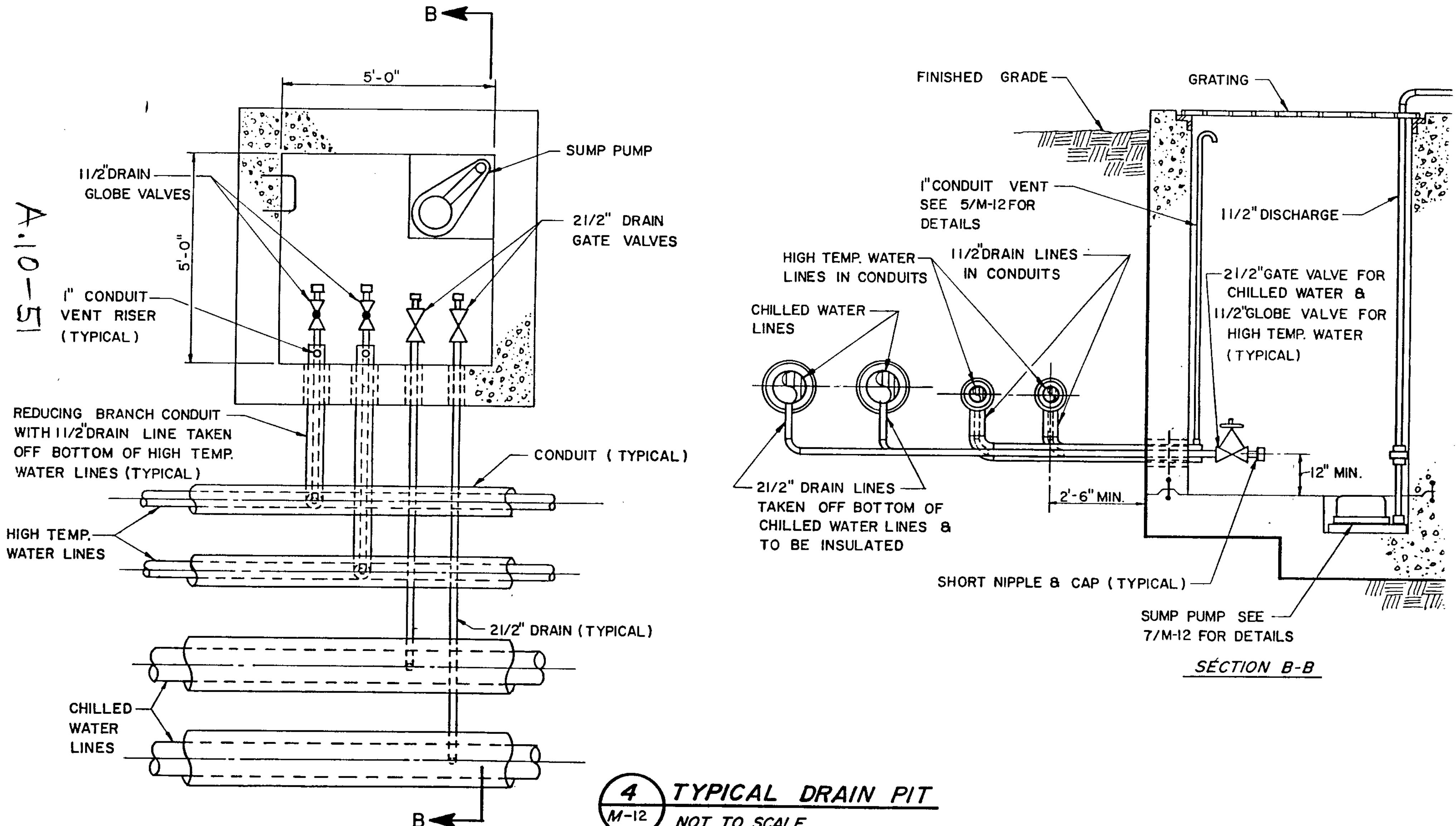



6 / M-12 TYPICAL LINE VENT RISER & AIR BOTTLE DETAILS

NOT TO SCALE

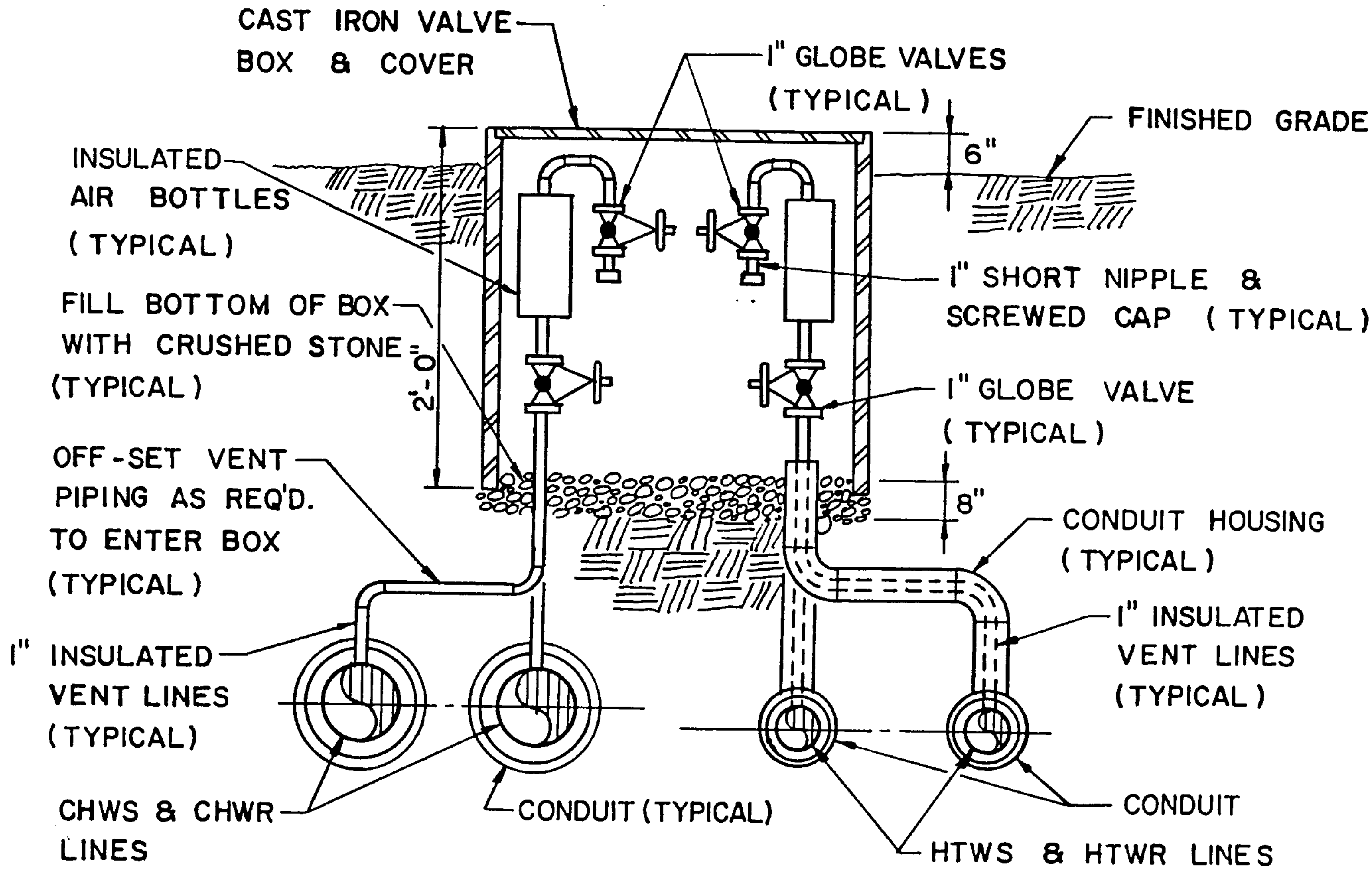
A. 10-50

A.10-51



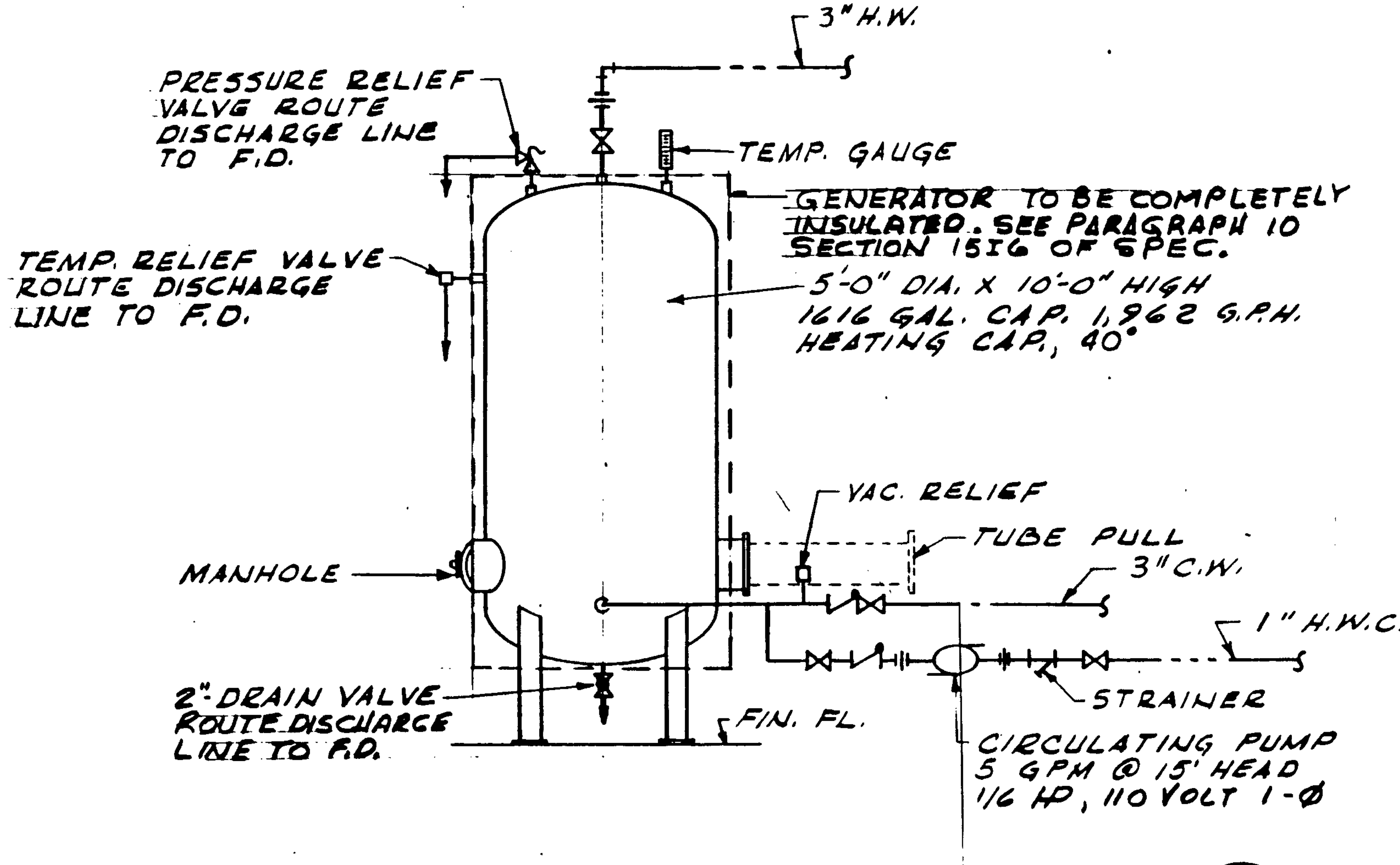

4 / M-12 **TYPICAL DRAIN PIT**

NOT TO SCALE




SECTION A-A

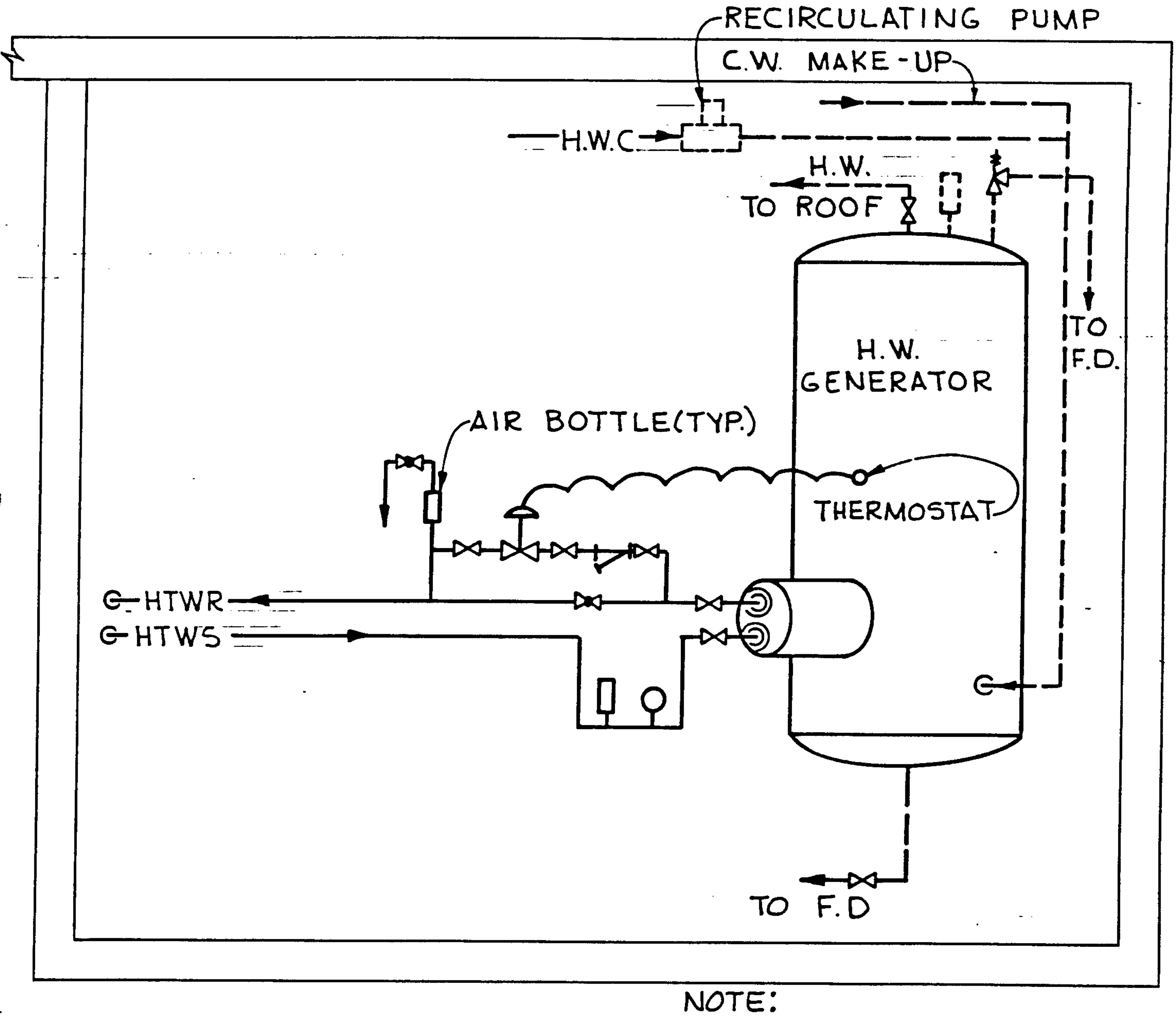
## VALVE BOX




# DETAIL WATER GENERATOR PIPING

A / M-10 / M-9

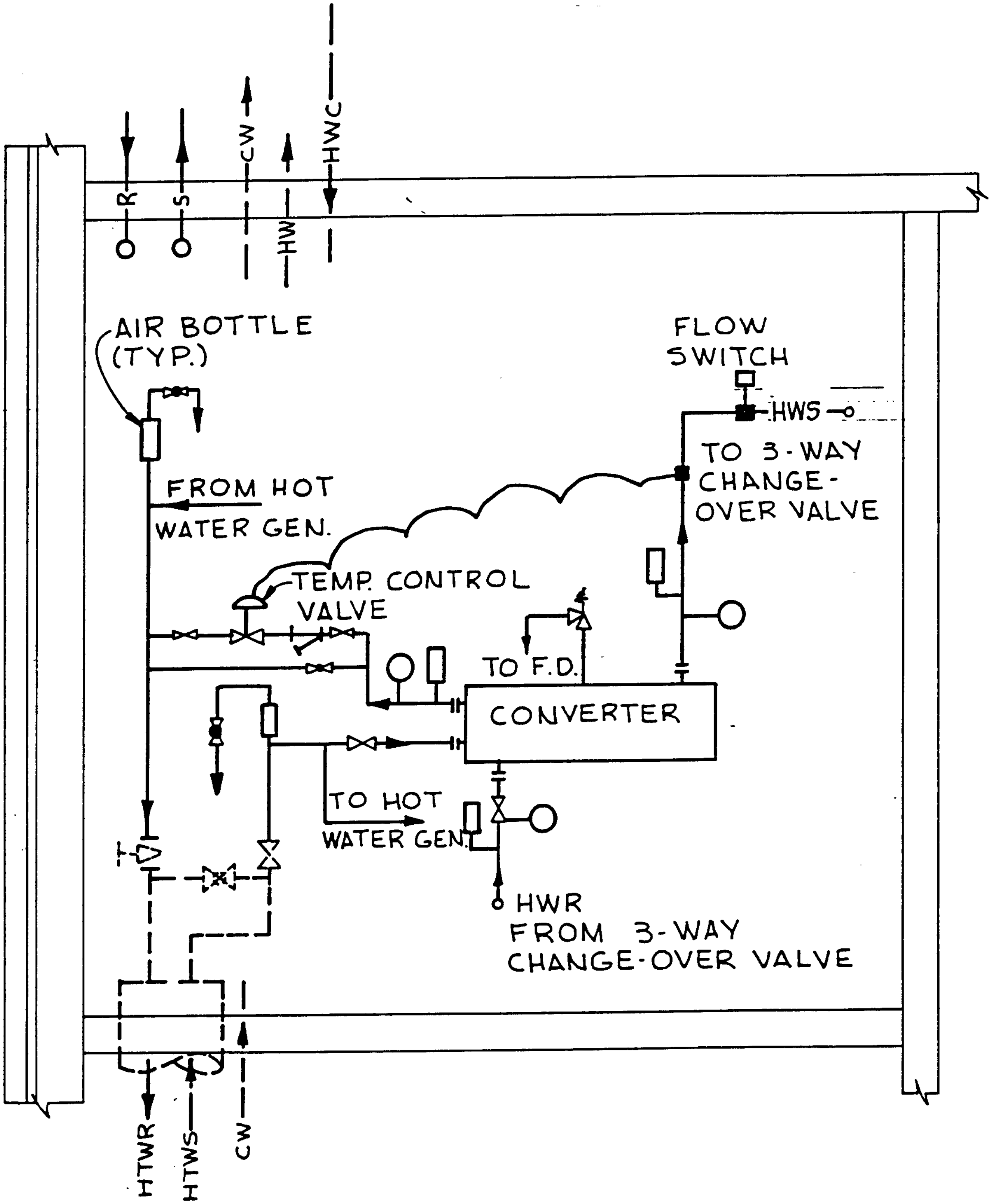
NOT TO SCALE




NOTE:
USE FLANGED CONNECTIONS
WATER CONNECTIONS TO H.\

SECTION 3 M-14 M-14

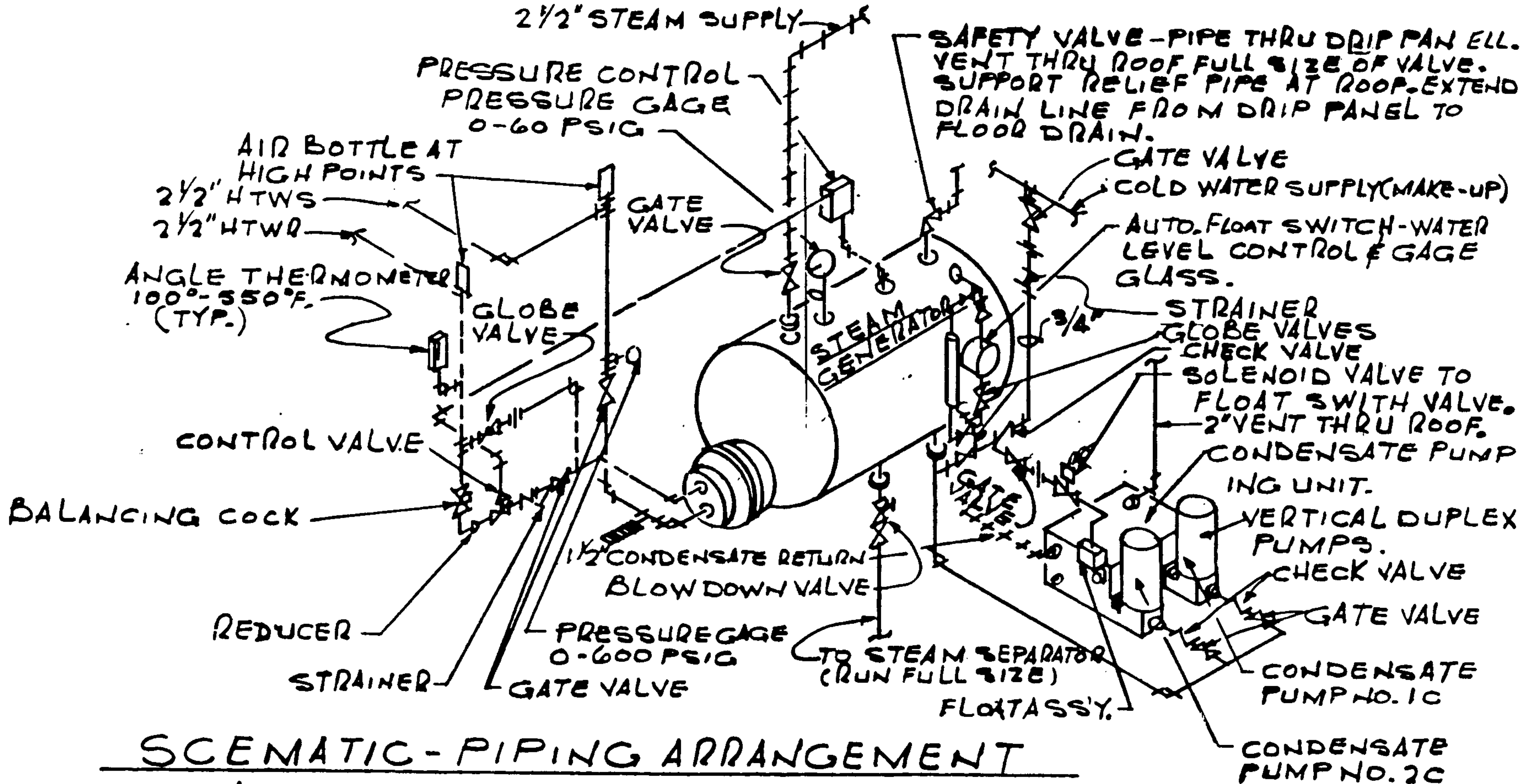
A.10-54 SCALE: $\frac{1}{2}$" = 1'-0"




SECTION 1 M-14 M-14

A.10-55

SCALE: $\frac{1}{2}$" = 1'-0"




SCEMATIC - PIPING ARRANGEMENT

H.T.W. STEAM GENERATOR

NOT TO SCALE